TECHNICAL MANUAL

OFFSET PHOTOLITHOGRAPHY AND MAP REPRODUCTION

HEADQUARTERS, DEPARTMENT OF THE ARMY

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OFFSET PHOTOLITHOGRAPHY AND MAP REPRODUCTION

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CHAPTER 1
INTRODUCTION

1–1. Purpose and Scope

a. This manual is intended to serve as a guide for training personnel in the reproduction of copy by offset photolithographic methods, and as a reference for personnel engaged in such work. It emphasizes the reproduction of maps and related materials by topographic units, but also discusses lithographic printing by other military lithographers.

b. This manual describes the photolithographic method of reproducing maps, photomosaics, books, pamphlets, forms, and similar material of a military nature. It discusses the principles involved in each of the major phases of the photolithographic process, and provides general instructions in the operation of the types of equipment necessary to each phase. Information on the operation and maintenance of specific equipment may be obtained from the operator's manual for each model.

1–2. Changes

Users of this manual are encouraged to submit recommended changes or comments to improve the manual. Comments should be keyed to the specific page, paragraph, and line of the text for which the change is recommended. Reasons should be provided for each comment to insure understanding and complete evaluation. Comments should be forwarded directly to the Commandant, U.S. Army Engineer School, Fort Belvoir, Va. 22060.

1–3. Safety

The reproduction procedures described in this manual call for the use of equipment and chemicals which, if certain precautions are not followed, may be dangerous to operating personnel. Specific safety precautions are noted where applicable.

1–4. Regulations and Instructions

a. At present, AR 117–5 governs the planning, compilation, reproduction, and distribution of all military maps and related material. It assigns to the Corps of Engineers the responsibility for performing topographic and geodetic services, and defines the functions of topographic units in the production of military maps. AR's of the 117 series are scheduled to be incorporated into the 115 series under the title of Environmental Services. No definite date for this consolidation has been established at the time of publication of this manual.

b. The U.S. Army Topographic Command (TOPOCOM), formerly the Army Map Service, in accordance with the provisions of AR 117–5, has published TPC TM S–1, containing detailed instructions for all phases of map preparation and reproduction. Specific instructions regarding quality control are published in TOPOCOM Bulletins, and in TPC Quality Standards. Commanders of topographic units may obtain copies of TOPOCOM Technical Publications List, TPC TM S–1, and other related publications by writing directly to Commanding General, U.S. Army Topographic Command, Washington D.C. 20315.

c. Policies governing military printing are set forth in AR 310–1. The preparation and processing of military publications are covered by AR 310–3. Regulations governing field printing and field contract printing and duplication for the military are contained in AR 310–1. Other instructions and procedures are contained in pertinent training manuals listed in appendix A.

CHAPTER 2
THE PHOTOLITHOGRAPHIC PROCESS

—1. History

[odern offset photolithography has evolved from :one lithography, the principles of which were iscovered in Europe in the late eighteenth cen- ıry. A man named Alois Senefelder found, when ə wrote on a slab of porous limestone with a reasy substance, and then wet the stone with ater, that ink would adhere to the greasy image ıt not to the rest of the stone. He could thus ake as many copies as he wished by wetting and ə-inking the stone before each impression. The rocess came to be called "lithography," which eans "stone writing," a name which has sur- ved to modern times. Artists and businessmen ıickly adopted the new way of printing because was so much faster, simpler, and cheaper than ıpperplate engraving, the most widely used ethod up to that time. The presses which were ıveloped for printing from stone were of the ıtbed type,—slow, clumsy, and cumbersome by ır standards, but efficient and economical for eir times. By the middle of the nineteenth cen- ry, the new science of photography brought ajor changes to the printing industry. An image uld be engraved by photographic methods on a in metal plate, which could then be mounted on rotary press, a vast improvement over the old ıtbed presses. Lithographers soon found that ıotography could also be used to put a chemically rdened lithographic image on metal plates, mak- g it possible to use rotary presses for what was w called "photolithography." These presses inted the image directly from plate to paper, wever, and thus were very limited in the type of per that could be used, and in the quality of the ıage. Ira Rubel is generally credited with the vention, in 1905, of the offset method of print- g. He noticed that if the paper feeder missed a eet when the press was running, the image ıuld be transferred instead to the rubber-cov- ed impression cylinder, then printed again on ə back of the next sheet. This unintentionally ffset" image was superior in quality to the di- ɛtly-printed image, and Mr. Rubel made use of ıs fact in developing a press in which the image was "offset" from plate to rubber cylinder, and then printed on the paper. All of the complex, high-speed offset lithographic presses of today are refinements of this basic idea.

2–2. Principles of Offset Lithography

a. Types of Printing. There are three principal methods of printing: letterpress, intaglio, and lithography. Almost all modern printing may be classified as one of these three types. In the letterpress method, the image area is raised above the surface of the printing image carrier, and therefore is the only part of the surface area which takes the ink and prints. In the intaglio method, the opposite is true. The image is cut below the surface of the plate, and when ink is applied to the plate and wiped off the surface, it remains in the engraved or sunken image areas, and is transferred to the paper. Lithography differs from both of these methods in that the image is neither raised above nor cut below the surface of the plate, but lies in the same plane as the nonprinting areas. The lithographic plate has been chemically treated so that only the image areas attract the ink, and the nonprinting areas remain clean. Figure 2–1 illustrates the differences between the three methods of printing.

b. Photolithographic Principles. All lithography, from the earliest days of printing from stones to the latest high-speed presses, is based on the simple fact that oil and water do not mix. The image carrier is moistened so that the greasy ink will adhere only to the image. This principle is applied in the modern plate-making process and during the operation of the press as follows:

(1) A sensitized metal sheet, usually aluminum, is exposed photomechanically to a negative containing the desired image. Wherever light penetrates the negative to the plate, the sensitized surface of the plate is hardened. In the developing process, these light-hardened image areas are retained, while the coating in the unexposed nonprinting areas is washed away. The image areas attract the greasy ink and repel water, while the

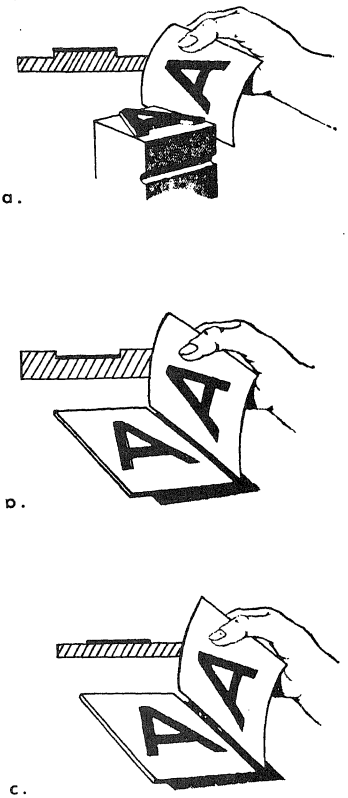


Figure 2-1. The three main printing processes.

a. Letterpress.
b. Intaglio.
c. Lithography.

nonprinting areas become water-receptive and ink repellent (fig. 2-2).

(2) The exposed and developed plate is mounted on a press which has both a dampening and inking assembly. As the plate cylinder rotates, it is first dampened with the water solution to make the nonprinting areas ink-repellent. The ink is then applied, adhering only to the image areas, thus making it possible to print only those areas on the final copy.

(3) In offset printing, the image is not printed directly from plate to paper, but instead is

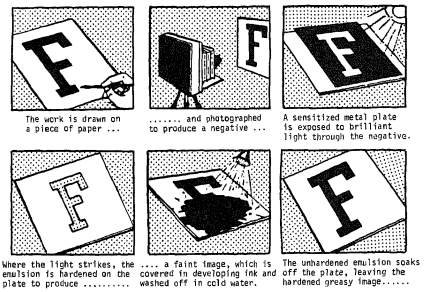


Figure 2-2. Photolithographic plate-making.

transferred first to a rubber blanket mounted on a cylinder, and then to the paper. This "offset" feature gives the lithographic press its great versatility. A greater variety of papers can be successfully used because of the resilience of the rubber blanket, making it possible to print on coarse as well as smooth stock. Because excessive amounts of either water or ink on the plate do not reach the paper, finer detail can be reproduced, and the paper does not so readily lose its size, making close registration between colors possible. On offset presses, the image on the plate is positive, or "right-reading," because it must be reversed on the blanket before it is printed, again in right-reading form, on the paper. This important feature is illustrated in the simplified diagram shown in figure 2-3.

2-3. Military Uses of Lithographic Printing

a. Offset photolithography in the armed forces is probably used most extensively for the reproduction of military maps. The high speed and long runs of the presses, coupled with the fine quality

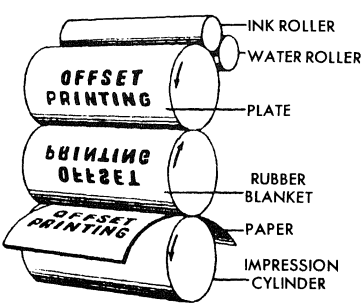


Figure 2-3. Offset principle.

of the printed product, make them ideal for meeting military mapping needs. Topographic reproduction units use this type of press for the reproduction of monochrome and multicolor topographic maps, photomaps, trig lists, and other printed items related to military mapping. The part played by the reproduction unit in the map production effort is indicated in figure 2–4.

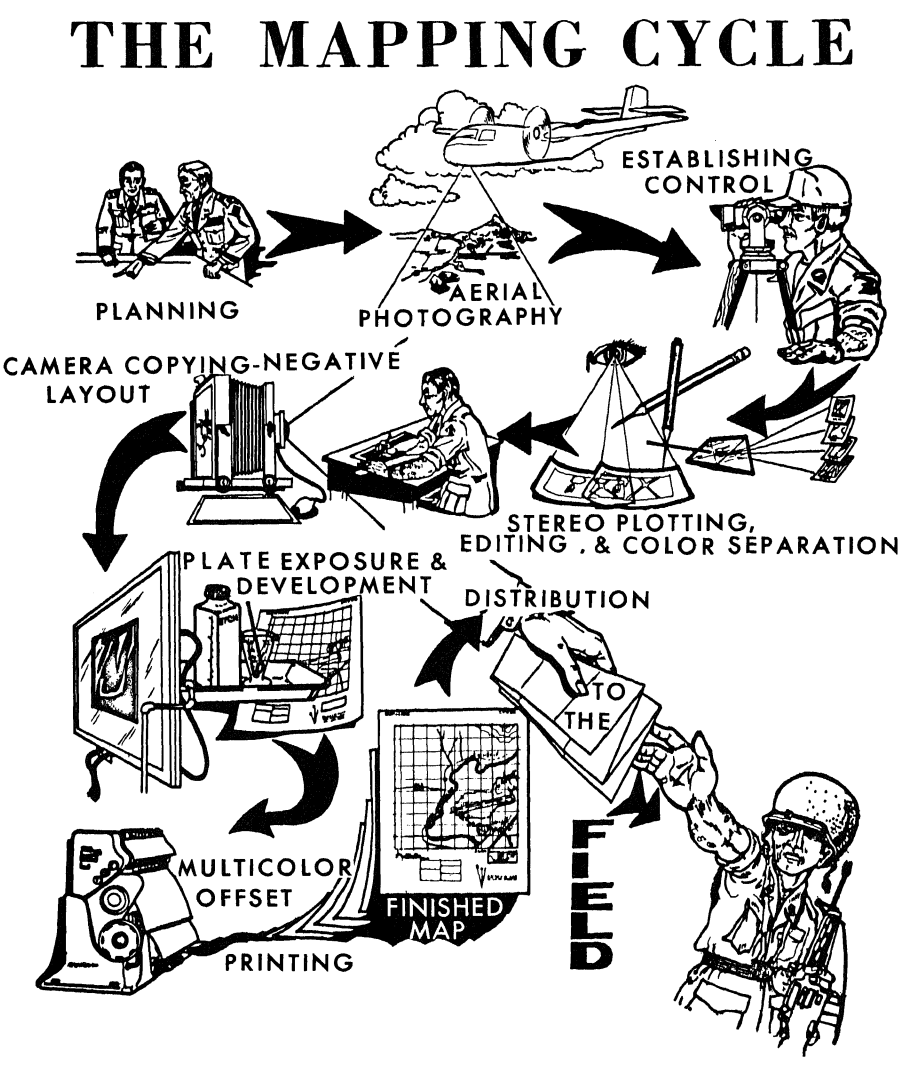


Figure 2–4. Mapping cycle.

b. Other military printers use offset lithography whenever the printing effort requires volume reproduction, relatively low cost, speed and quality. Printing plants in the armed services print such diverse products as books, forms, leaflets, and posters, ranging in use from classroom texts to psychological warfare material.

c. The chapters in this manual emphasize the various phases of the photolithographic process in the reproduction of maps and related topographic products. Factors affecting other military uses of lithographic printing which differ basically from map reproduction are also discussed in the appropriate chapters.

2–4. Phases in the Photolithographic Process

a. Map Reproduction. There are five basic phases in reproducing a map by the photolithographic process. These include production planning, copying the original material photographically with the process camera, making negative corrections and layouts, making the plates, and printing the map on the offset press.

(1) Production planning consists of studying the production request, reviewing the materials received for adequacy, scheduling production personnel, ordering supplies, and preparing the necessary work orders. Since the specifications for cartographic compilation and color separation are so detailed and exacting, and the format for each standard series is so well established, there is little or no copy preparation necessary on the part of map reproduction personnel before the camera phase. Planning operations are discussed in chapter 3; copy preparation is discussed in chapter 4.

(2) Photographing the map copy involves mounting a light-sensitive film in the back of a process camera, mounting the copy on the copyboard of the camera, exposing the film to the image on the copy by means of the action of light through the camera lens, and developing a usable negative. The process photography phase of the photolithographic operation is treated in detail in chapter 5.

(3) In the negative correction and layout stage, the negatives are examined for defects, and pinholes and any extraneous images are opaqued. If corrections to the image are necessary, they are either engraved on the negative, or stripped in with a set-in and taped portion of negative containing the corrected images. Layout consists of assembling and positioning the negatives in the desired location on a support flat. This assembly will be used to make the printing plate. In map reproduction on the smaller field presses, only one negative image, rather than an assembly, is positioned on each flat, but if the map is multicolor, this positioning is critical, since the registration of the various colors to each other depends on its accuracy. Chapter 6 contains a detailed discussion of layout procedures.

(4) In the platemaking phase of the photolithographic process, the image is transferred from the negative flat to the press plate. The sensitized plate is mounted in a vacuum frame with the masked copy negative placed over it, and is exposed to light. The latent image on the plate is then developed. The developer fixes the exposed, ink-receptive image on the plate and removes the nonprinting portions, exposing the water-receptive surface of the metallic plate. The plate is then ready for the press. Platemaking procedures are described in chapter 7.

(5) Offset printing on a modern lithographic press is an automatic machine operation. The pressman, however, must first make all necessary adjustments to the ink and fountain assemblies, the plate, blanket and impression cylinders, and the feeder and delivery assemblies to assure smooth and proper operation of the press and printed images of acceptable quality. Reproduction of a multicolor map on a single color press requires that the plate be changed, the press cleaned and reinked, and the paper rehandled for each color, and that the registration between colors meet exacting tolerances. Information regarding the operation of offset lithographic presses is given in chapter 8.

b. Reproduction of Copy Other Than Maps. Similar procedures are followed for the photolithography of nonmapping material, with certain modifications and additional phases as required by the nature of the printing job. All good lithography depends upon careful and thorough planning, but non-map material may require considerable copy preparation on the part of lithographic personnel. If it is received in a very rough form, it may require type selection, setting, and proofing, finishing of art work furnished as sketches, and arrangement of art and type into a pleasing design. The process cameraman, in addition to making negatives suitable for platemaking, may also be called upon to color separate copy photographically by the use of filters, or to alter the size or the nature of the copy by photo techniques. Layout for non-map work usually is more complex, especially in the preparation of book pages or folded pam-

phlets. Plate-making and press operations are similar for all kinds of lithography, but finishing operations vary considerably. Maps usually are packaged flat for distribution, but other copy may require cutting, folding, hole punching, binding, stapling, or other treatment.

CHAPTER 3
PLANNING

Section I. PLANNING FOR MAP REPRODUCTION PROJECTS

3–1. Introduction

Planning is the art of determining the manpower, machinery, materiel, and methods needed to meet given requirements. It involves estimating costs, scheduling the utilization of materiel and manpower, establishing production target dates, and issuing the necessary orders and directives to get the job done. Planning for a map reproduction unit is essentially the same as planning for any other type of Army unit in which many special skills and capabilities must be coordinated and organized for maximum efficiency and high quality production.

3–2. Determining Requirements

Production requirements are specified by the theater, army, or corps to which the map reproduction unit is assigned. The planning necessary to satisfy these requirements is the responsibility of the map reproduction unit operations officer. It is his duty to plan the job in such a way that his men can complete it in a minimum amount of time.

3–3. Determining Production Capabilities

The primary factors involved in determining production capabilities are:

a. Personnel Evaluation.

b. Equipment.

(1) Number and types of pieces on hand.

(2) Condition of the equipment.

(3) Capabilities of the equipment.

c. Plant Layout.

(1) *Base plant.* A base plant should be laid out efficiently so that the work flows smoothly from the camera to the point where the finished maps are shipped out.

(2) *Field plant.* A field plant is laid out essentially the same as a base plant, but proper military dispersion and camouflage measures are also to be taken into consideration. These considerations may make the field plant layout slightly less efficient and smooth flowing than the base plant layout.

3–4. Schedules

a. When map copy is sent for reproduction, instructions are included as to the size and scale of the finished map, number of colors, length of run (quantity), type of stock, classification, and required delivery date. Using this information, the operations section determines whether the job can be handled in the submitted form, whether all necessary information has been furnished, and whether limitations of the equipment require modification of the instructions. The job is then classified and assigned a priority and sequence number. Instructions on operations and routing through the plant are entered on a work order prepared in duplicate. One copy of the work order accompanies the map copy, and the other is kept in the files to check scheduling and progress. When the copy is small, the scheduling work order is prepared on a standard file-size envelope into which the copy notes, and prepared negatives or positives are later inserted for filing. Where possible, large copy is routed in protective envelopes or containers with the work order sheet attached. Complete handling instructions should be put on the work order to assure coordination of the job and to minimize errors in passing on information (fig. 3–1).

b. The operations office should have a large, wall-mounted scheduling board listing job progress and promised and actual delivery dates. A blackboard prepared with painted titles and outlines to show scheduled time ahead and availability of presses, paper, inks, and plates in stock is also helpful in making quick time estimates.

c. In base units and in those using several presses, production board control cards may be used to control the printing sequence according to priority and to keep production and operations

FOR TRAINING PURPOSES ONLY

WORK ORDER	WORK ORDER NUMBER	DATE ASSIGNED	DATE DUE	DATE COMPLETE
ASSIGN TO: GEOD / TERR / INTEL / SURV / PHOTO / REPRO	JOB TITLE			SECURITY: TS / S / C / U
REQUESTOR	REQUESTORS ADDRESS			REQUESTORS NO.

TOTAL FINISHED COPIES REQUIRED	GEODETIC DUE	TERRAIN DUE	INTELL DUE	SURVEY DUE	PHOTO DUE	REPRO DUE

MATERIALS FURNISHED

FILM NEGS		CHARTS		PLANE TABLE SHT			
FILM POS		MANUSCRIPT		CONTROL BKS			
PHOTOSTAT NEG		LINE DWNGS		TRIG LIST			
PHOTOSTAT POS		BOOK-MANUAL		GEODETIC			
PHOTOGRAPHS		TYPED COPY					
BLUELINE BDS		OVERLAY (PLASTIC)					
MAP SHEET(S)		OVERLAY (CLOTH)					
SCRIBE SHEET		OVERLAY (PAPER)					
OZALID		TRACING					
FORMS		DIAPOSITIVES					

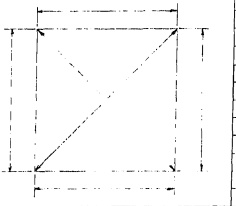
WORK CLASSIFICATION

MAPPING PROJ		DEVELOP FILM		REPRINT	
CONTROL CHK		CONTACT PRINT		COLOR PROOF	
LEROY		ENLARGEMENTS		OVERLAY	
TYPESETTING		OZALID		OVER PRINT	
COMPILATION		TRACING			
DRAFTING		STICK-UP			
SCRIBING		FILM POS			
ART WORK		FILM NEG			
MOSAIC		PHOTOSTAT NEG			
DIAPOSITIVE		PHOTOSTAT POS			

STOCK

BRISTOL BD		HI-WET	
ACETATE		BOND	
STABLE PLASTIC		MANIFOLD	
VINYL CHLORIDE		COATED (1S) (2S)	
TRACING PAPER		CARD	
TRACING CLOTH		SCRIBE COAT	
CELANESE			
FLOW TISSUE			
MANILA DWG			
CHLORIDE (SW) (DW)			
BROMIDE (SW) (DW)			
PHOTOSTAT (SW) (DW)			

REPRODUCTION SCALE DATA



1:1
TO MAKE LINE
HORIZONTAL TO
VERTICAL TO
ENLARGE TO
REDUCE TO
SEE REMARKS

FINAL TRIM SIZE
HORIZONTAL × VERTICAL

MAKE-UP AND LAYOUT

MARGINS		TO PRINT	
LEFT		1 SIDE ONLY	
RIGHT		HEAD TO HEAD	
TOP		HEAD TO TOE	
BOTTOM		HORIZONTAL PAGE	
CENTER		VERTICAL PAGE	
SCREEN		WORK AND TURN	
STEP AND REPEAT		WORK AND FLOP	
SINGLE FOLD			
MULTIPLE FOLD		FOLLOW SAMPLE	

COLORS

SPECIFY AMS CODE IF APPL.

COLOR	
BLACK	
RED	
BLUE	
BROWN	
GREEN	
MATCH SAMPLE	

BINDING

STAPLE		PUNCH	
1 UL-UR		2 RING BDR	
2 UL-UR		3 RING BDR	
2 LE		ACCO TOP	
3 LE		ACCO LS	
2 SADDLE		PAD	
4 SADDLE		SHTS IN	
		EDGE	
COLLATE		FOLD	
MOSAIC		DUMMY	

CONTROL

WRITTEN BY	
APPROVED BY	
RECEIVED IN UNIT BY	DATE
RECEIVED IN S-3 BY	DATE

RECEIPT

AGENCY	
DATE	TIME
SIGNATURE	
ORIGINAL	COPIES

FOR TRAINING PURPOSES ONLY

Figure 3-1. A map reproduction unit work order.

WORK ORDER	WORK ORDER NUMBER	DATE ASSIGNED	DATE DUE	DATE COMPLETE
ASSIGN TO: GEOD / TERR / ENGR INT / PHOTO / REPRO	JOB TITLE			SECURITY: TS / S / C / OU
REQUESTOR	REQUESTORS ADDRESS			REQUESTORS NO.
SPECIAL INSTRUCTIONS				

SECTION	UNITS	MAN HOURS	SECTION	UNITS	MAN HOURS	SECTION	UNITS	MAN HOURS

Figure 3–1.—Continued.

personnel informed of the status and disposition of the jobs in the plant. These cards, in the colors to be printed on each job, are distributed on the control board by press and in the order to be printed. At a glance, the press operators, the press foreman, and the officers in charge of operations and production can see what is on the presses and what will be printed next on each press. Production estimates and time of job completion for any job may be quickly ascertained.

3–5. Estimating Time Requirements

a. Considerations. Estimating the time required for completing a job includes consideration of the following factors: copy suitability; amount of artwork, drafting, and corrections necessary; availability of chemicals, solutions, and supplies; the time required for chemical and mechanical preparations; equipment available; and the actual operating time. The skill and efficiency of the operators and the possibility of unforeseen delays must be considered in estimating total time requirements.

b. Operation Times. Suggested operation times for typical jobs follow. These are estimates only and should be modified by actual time records obtained under operating conditions.

Operation	*Time*
Estimating, scheduling, and preparing work orders	1 hr.
Editing, correcting, and adding to artwork (estimate depends on condition of copy. It may require from 15 minutes for simple additions of reference marks and numbers to several days for extensive corrections)	15 min
Negative making:	
Initial preparation of chemicals and equipment	1 hr
Line negatives—	
First, scale focusing	15 min
Accurate ground glass measurements	30 min
Each additional negative at the same camera setting	10 min
Halftone negatives—	
First, including setting screen and camera	1 hr
Each additional negative at the same camera setting	30 min
Color separations (When using filters with line or halftone negatives, time depends on the filter used. As an approximation, add 50 percent to the estimated negative-making time for line negatives, and 100 percent for halftones.).	
Processing the negative, including washing	45 min
Waiting for the negative to dry	½ hr
Negative opaquing and retouching, minimum	30 min
Layout:	
One negative on a plate (on a combination plate, add 10 minutes for each additional negative)	15 min
Plate making (sensitized aluminum plates):	
Exposing, developing, and finishing a plate	15 min
Press runs:	
Initial preparation and makeready time	2 hrs
Estimated production (impression per hour (IPH))—	
Single-color line wirk	3,500 IPH
Color register work, each color	3,000 IPH
Makeready time, each additional plate with same color	30 min
Makeready time, with washup of press for change of ink color, each color	45 min
Cleanup press at end of day's run	30 min
Packaging and labeling maps for distribution, per ream package (500 sheets)	15 min

c. Typical Time Estimates. Examples of estimates made on the basis of the above operation times are given below.

(1) *Copy.* Simple, single-color line map; same size reproduction; 500 sheets required.

Operation	*Time*
Administration, planning, and preparation of work order	1 hr
Editing, correcting, and adding to artwork	15 min
Making the negative (this includes putting the material to be copied on the copyboard of the process camera; focusing and checking for scale; exposing the film; and processing the negative, including washing it)	1 hr
Waiting for the negative to dry	½ hr
Opaquing and retouching the negative	30 min
Laying out the negative	15 min
Making the plate (this includes putting the masked negative and the sensitized plate in the vacuum frame, exposing the plate, and developing the plate)	15 min
Offset press makeready	30 min
Running 500 sheets	15 min
Total production time	4½ hr
25 percent allowance for contingencies	1½ hr
Total time estimate	6 hr

(2) *Copy.* Four-color map; color separation material furnished: five scribed plastic negatives and four plastic overlays; 30,000 copies required.

Operation	*Time*
Administration, planning, and preparation of work order	1 hr

Operation	Time
Editing, correcting, and adding to artwork (15 min for each drawing)	2½ hr
Making the negatives of overlays (1 hr for each)	4 hr
Waiting for the negatives to dry	2 hr
Negative opaquing and retouching (½ hour each)	2 hr
Negative layout (15 minutes each)	2½ hr
Plate processing (sensitized) (15 minutes per plate)	1 hr
Press operation:	
Adjustment of press and preliminary makeready can be complete by the time the first-color plate reaches the press. Estimating that the first color plate takes about 3 hours, press operation for the remainder of an 8-hour day includes—	
Makeready time	½ hr
Running time (production 12,500 first-color prints, 3,000/hr)	4¼ hr
Press cleanup at end of day	½ hr
Starting press in the morning	1 hr
Production during second day (allowing 1 hr shutdown at noon) about 18,000 first-color prints	6 hr
Press time for each additional color on a 30,000 run (color runs usually are 10 percent more than required, this allows for waste)	
Second color	14 hr
Third color	14 hr
Fourth color	14 hr
Packaging and labeling 30,000 maps in one-ream packages, 60 at ½ hr	15 hr
Total production time	84½ hr
25 percent allowance for contingencies	20 hr
Total time estimate	104¼ hr

(3) *Copy.* Photomosaic, 10,000-yard rectangle at 1:25,000; grid lines to be added; lettering for marginal data already mounted in position on a stable base overlay; single-color reproduction; 2,000 copies required.

Operation	Time
Administration, planning, and preparation of work order	1 hr
Editing, and adding register marks	½ hr
Negative making:	
Line negative of marginal data	½ hr
Halftone negative of mosaic	1 hr
Waiting for the negatives to dry	2 hr
Negative opaquing and retouching (includes preparing negatives for multiple exposure on the press plate because stripping would require more time and be less satisfactory. Also includes ruling grid lines and opaquing to borders. Time can be saved by having standard-grid negatives and positives to permit combination or multiple exposure on press plate)	2 hr
Negative layout	45 min
Making the plate (sensitized)	15 min
Press makeready	30 min
Press run of 2,000 copies	45 min
Total production time	9¼ hr
25 percent allowance for contingencies	2¼ hr
Total time estimate	11½ hr

d. Overlap of Operations. Considerable time can be saved in larger jobs with many pieces of copy by starting certain phases while the preceding one is still being performed. For example, opaquing can be started for the first negatives completed, while waiting for remaining negatives to dry. Similarly, layout for opaqued negatives can be started while others are still being touched up. Sufficient personnel must be available to work concurrently on the various phases of negative preparation and press operation.

Section II. PLANNING FOR OTHER TYPES OF MILITARY PRINTING

3–6. General

Careful planning, estimating, and scheduling are as necessary for other types of printing projects as for map reproduction, and are accomplished in much the same manner. There are certain aspects of some types of printing, however, which require attention on the part of the planning unit which normally are not a concern of map reproduction personnel. The work request, unlike mapping projects, may be very general, and the copy may be in very rough form. Some printing plants may be large and well-equipped, with a variety of equipment and trained personnel to carry out almost any type of lithographic project. Other units may have minimum equipment, suitable only for fairly simple printing jobs.

3–7. Type of Copy

Copy may range from simple one-page forms to bound books. The planner, in some cases, may have the responsibility for determining the nature of the copy; whether it will be most effective as a leaflet, pamphlet, booklet, or other format. This will depend partly upon the type of cutting, folding and binding equipment available in the finishing department. At the same time a size must be

chosen which will provide the most copies with the shortest press run on the presses available. In some cases, much time and money can be saved by a small change in copy size or by the use of a larger or smaller press.

3-8. Copy Preparation

The amount of copy preparation necessary for a project seriously affects the flow of work and must be carefully considered in drawing up time schedules and cost estimates. The reproduction unit may be responsible for the basic design of a project, choosing the sizes and styles of type, determining the kind and amount of art work necessary, preparation of the final copy for the camera, and the arrangement of all the components into a pleasing composition.

3-9. Materials

It is the duty of the planning unit to assure that all necessary materials and equipment, as well as personnel, are available to do the job, and to order needed supplies in adequate quantities sufficiently in advance of need to avoid delays and bottlenecks in the flow of work. Overstocking should be avoided for all chemicals and pre-sensitized materials that have a limited shelf life.

CHAPTER 4
COPY PREPARATION

Section I. PREPARATION OF MAP COPY

4-1. Responsibility

a. General. Preparation of map copy for standard topographic maps and photomaps is the responsibility of the photomapping unit and normally is not a function of the map reproduction unit. Occasionally, however, the color-separation drawings are incomplete and the corrections or additions must be made by the map reproduction personnel. A general knowledge of copy preparation, drafting procedures, and working expedients is therefore desirable for map reproduction unit personnel. A brief discussion of the principal methods of map preparation is given in this section; a detailed presentation of these procedures may be found in TM 5-240 and TOPOCOM TM S-1.

b. Pictomaps. A pictomap is a new topographic product which is essentially a color-enhanced photomosaic, on which the photographic image has been converted into interpretable colors and symbols by photo-mechanical means. The preparation of copy for pictomaps, unlike that for traditional line maps and photomaps, is partly a reproduction function, and requires close cooperation between photomapping and reproduction personnel. See paragraphs 5-29—5-31 for a discussion of the functions of the reproduction unit in the pictomap process.

4-2. Mapping Specifications

a. Publications. The U.S. Army Topographic Command (TOPOCOM) is authorized to prepare the basic specifications for military maps produced by Corps of Engineers topographic units. TOPOCOM TM S-1 provides complete instructions for the preparation of standard large, medium, and small scale topographic maps, and pictomaps. Joint Operations Graphics (JOG's) are compiled, color-separated and reproduced in accordance with the Production Specifications for series 1501 and series 1501 AIR, prepared under the direction of the Defense Intelligence Agency (DIA).

b. Map Colors. Standard printing colors for military maps are listed in TM S-1, and in the JOG specifications. The coded letters and numbers shown with each color in these publications are those established by TOPOCOM to identify the specific shades of each color to be used. Topographic units are issued these prescribed inks and may not deviate from them except under expedient conditions.

c. Monochrome Maps. Since each added color requires an additional press run, expedients in copy preparation are sometimes used to reduce the number of printings to a minimum. One expedient is to use tints or process screens to produce tones or patterns to convey the information normally represented by colors. By appropriate drafting and the use of process screens, it is sometimes possible in a single printing to reproduce roads, contours, rivers, bodies of water, and the nature of vegetation and woodlands in a single color. Clear fineline symbols must be used for single-color maps to avoid overlapping and to prevent adjacent data from confusing the user. The printing of single-color, detailed maps in a light, neutral gray or blue shade for subsequent overprinting of special information is a useful adaptation of the single-color map.

d. Standard Map Scales. The standard military map scales are 1:50,000, 1:250,000, and 1:1,000,000. Map scales of 1:25,000 and 1:100,000 are acceptable only if they show better coverage or later information than the 1:50,000 and 1:250,000 maps, respectively. The scale of 1:12,500 is the preferred scale for city maps.

e. Map Sizes. Map sheet sizes are those maximum sizes which can be accommodated on field reproduction presses and commercial presses. The sizes have been adopted by international standardization agencies, with U.S. participation, and are expressed as—

(1) Maps of 1:250,000 and larger scales (other than military city maps and town plans)

shall not exceed a maximum sheet (trim) size of 22.50 x 29.00 inches (57.15 x 73.66 cm).

(2) All other maps shall not exceed a maximum sheet (trim) size of 33 x 44 inches (83.8 x 111.7 cm), and preferably not more than 28 x 43¼ inches (71.1 x 109.8 cm).

4–3. Description of Good Copy

Satisfactory copy closely approaches the desired appearance of the final printed map. It is neatly drawn or engraved with sharp, clear lines and characters. It is accurate and fully detailed, and includes complete instructions and dummy mockups for color or tint areas. It also includes the reference marks or registration holes which are required throughout the reproduction procedure. Color separated drawings are carefully registered to each other.

4–4. Types of Map Copy and Copy Preparation Methods

a. Scribed Plastic Negatives. The plastic scribing process has largely replaced ink drafting in the color-separation phase of cartographic drafting. Instead of positive ink tracings of the blueline images printed on metal-mounted paper or lacquered plates, the process consists of scribing or etching a negative image printed on a pigment or dyetype coating on a plastic base. The coated plastic material is dimensionally stable to minimize registration problems. The scribe-coating is translucent, but is of such a color that it will not transmit blue, green, or violet light to which orthochromatic photographic materials or lithographic plate coatings are sensitive. The completed scribed negative can then be used directly for the preparation of the press plate or for the preparation of photographic positives. A separate scribed negative is prepared for each color that is to appear on the printed map.

b. Type Overlays. Since the image on the coated plastic is scribed in negative form, names, labels, prepared patterns, and prepared symbols, which are usually in positive form, must be shown separately on a matte-finish translucent overlay of the same plastic used as base for the scribecoat. By using the same kind and weight of plastic, differential changes in size which might affect registration are avoided. A separate type overlay is prepared for each color in which type or prepared symbols are to print; this overlay must be exactly registered to the scribed negative it supplements. A film negative must be made from each type overlay before it can be used in making the press plate.

c. Open-Window Negatives. Another type of color separated copy which is widely used for large area features or tints is called an "open-window" negative. This is a negative which has clear areas wherever the image symbol pattern or tone occurs. It is exposed together with a negative screen containing the desired symbol pattern or tone, which prints only in the clear areas. At one time, open-window negatives were inked and opaqued manually, either in positive or negative form, depending on the nature of the areas being depicted. It is necessary to make a film negative of copy inked in positive form, in order to expose the screened image in the correct areas. The *peelcote* process has largely replaced the laborious and time-consuming inking-and-opaquing method of preparing open window negatives, and eliminates the need to photograph a negative from the manually prepared opaque drawing. *Peelcote* consists of a plastic base similar to that used for scribed negatives, but with a coating that can be cut or etched, and then peeled up to expose large open areas, forming the "open-window" negative. Although the coating may be sensitized to receive a photographic image of the outlined area which is then etched into the coating by the developing process, the procedure requires equipment and chemicals normally not available to military users in the field. In field use, the area outlines are manually cut with etching tools. Besides saving considerable time in copy preparation, the use of open-window negatives insures that the tone of the tint or the quality of the symbols will be uniform, and that no join lines or mismatches between sheets of pattern will occur.

d. Blueline Processed Paper. The colors of a map manuscript can be separated by processing a positive image of the compilation in nonphotographic blue on specially treated paper, usually mounted on metal or board for dimensional stability. The desired map features are traced with ink, and the necessary type and prepared symbols are affixed directly to the blueline tracing. A film negative is then made for plate processing. A separate blueline image of the compilation is prepared for each desired color.

e. Bromide Prints. Ink drawings can be prepared to agree with photographic detail by drafting directly on a special, pale-toned photographic print. The silver image is then dissolved, leaving the inked drawing on the cleared photographic paper. This process is used for making line draw-

ings from photographs, or for redrafting line sketches, symbols, or insignia that are poorly drawn or printed. Chloride or bromochloride prints may also be used.

f. Photomaps. Photomaps are an assemblage of photographs adjusted to a specified scale and paneled to control points plotted on a projection. It is necessary for the reproduction unit to convert the continuous-tone photo image to a screened halftone image at the platemaking stage. See paragraphs 5–20 through 5–25 for a discussion of the preparation of halftone negatives.

g. Pictomaps. The preparation of copy for pictomaps is a joint endeavor of the photomapping and reproduction units. The original photomosaic and the engraved or drafted masks for the various line and spot symbols and type are prepared by the photomapping unit, but the extraction of the various tones of the photo image to be printed in the pictomap colors is a photochemical process, performed by the reproduction unit. There are several methods of obtaining the final copy from which the press plates are made. Each method produces, from the original continuous tone negative, a series of contact and reverse positives and negatives which drop out certain unwanted tones and enhance the desired ones (para 5–29). The three pictotone plates are made by combining a composite positive of all the block-out masks with each of three final photo products: the landtone plate, from the pictotone reverse positive, plus mask positive; the vegetone plate, from the pictotone negative, plus mask positive; and the shadowtone plate, from the pictotone drop-out negative plus mask positive. Color-separated copy, in addition to that used for masks, is prepared by the photomapping unit for contours, drainage, grid, marginal data, and other features as required (para 5–29—5–31).

4–5. Processing Map Copy

a. Copy Preparation Functions. Although the map reproduction unit is not responsible for the preparation of map copy, except in the production of pictomaps, it may be required to perform any of the following functions in copy preparation:

(1) Prepare blueline images of the compilation on coated plastic for scribing, or on paper, for inked drafting.

(2) Clean copy.

(3) Repair damaged scribecoat.

(4) Repair broken or pale type or symbols.

(5) Attach loosened stickup.

(6) Add register marks.

(7) Prepare film negatives of color separated overlays.

(8) Dodge (balance lighting) during exposure to compensate for uneven copy.

NOTE

Minor corrections are made on the negative or press plate. Changes on the original copy are made only with the approval of the officer in charge.

b. Methods of Making Copy Corrections.

(1) *Major corrections.* If detail is obliterated, stickups separated, or copy warped or distorted, refer immediately to the originating organization. Do not try to correct or reassemble.

(2) *Minor corrections.* Minor damage, such as tears, scratches, strains, folds, and creases, are corrected during reproduction.

(*a*) To mend tears, paste or join the back of the copy, using rubber cement or self-adhesive tape. Do not apply tape or patches to the face of the copy because they photograph differently and the edges will show on the negative. Do not use gummed tape or water-soluble pastes in applying patches to paper copy because they distort copy unless it is mounted on metal or fiberboard.

(*b*) For minor scratches, chipping of ink, or gray lines or lettering, make corrections on the negative.

(*c*) Scratched or chipped coating on scribed negatives is repaired by opaquing.

(*d*) Do not try to remove grease and oil strains from copy. Solvents may spread grease, cause inked impressions to bleed, or loosen stickups or copy from the base (some stains can be eliminated photographically by using orthochromatic film with an appropriate filter). If stains reproduce, retouch on negative.

(*e*) Although creases and wrinkles are usually minimized by proper camera techniques, better results are obtained by mounting the copy on a metal or fiberboard base. Copy must not be rolled or folded, and if received in this condition, must be flattened carefully to avoid creases or surface cracks.

c. Making (During Preparation Stage).

(1) *White masks.* White paper masks are used on copy in positive form around map borders, on areas where the work is to be deleted, and on large blank areas of copy that are spotted or dirty, to reduce the opaquing required on the negative.

(2) *Black masks.* Similarly, black paper

masks on positive copy produce clear areas on negatives for stripping in line or halftone films. Black paper is also used as backing for thin copy printed on both sides to prevent the detail on the back from showing through and recording on the negative.

(3) *Goldenrod.* When it is necessary to mask portions of negative copy, goldenrod, or similar opaque material is used.

d. Attaching Stickups. Wax applied to the back of type provides the best adhesive and should be used if equipment to apply the wax is available. If it is not available, use rubber cement for attaching stickups. It must have the proper consistency to adhere to the paper or plastic surface without penetrating into or staining the material.

e. Register and Corner Marks. All copy must have register, corner, trim, or other reference marks to aid in printing, cutting, and folding, and for color register. These generally are drawn as fine black lines. If copy is received without reference marks, an expedient method is to prepare printed copies of reference marks, color-control scales, and other standard data. Since many maps are not true rectangles and some are bordered with curved lines, carefully locate corner and center marks because they are used by the press operator in squaring the work with the sheet of paper.

Section II. OTHER COPY PREPARATION

4-6. General

a. The amount of copy preparation required for a non-mapping lithographic project can vary considerably. For some projects, the material provided is in such finished form that it is ready to be photographed with little preliminary work on the part of the reproduction unit. This usually is true of simple one-page items such as forms. Books, pamphlets, and display material which combine text and illustrations, however, often require much preliminary processing by reproduction personnel before it is ready for the plate layout stage.

b. Copy preparation may consist of selecting size, style, and arrangement of type, setting type on cold type composing machines, designing and preparing original art work, and assembling, arranging, and pasting up work for the camera.

c. A detailed discussion of the many aspects of non-mapping copy preparation is beyond the scope of this manual; however, a brief review of the more important elements as they may affect the military lithographer is presented in the following paragraphs.

4-7. Type and Textual Composition

Some smaller reproduction units have limited or no facilities for typesetting. In larger plants, however, with more extensive equipment, reproduction personnel may be required to select the sizes and styles of type, as well as prepare reproduction copies for printing. Copy may be in the form of reproduction proofs of hand-set type, negatives or proofs produced on a phototypesetting machine, typewritten material, or material prepared on one of the numerous versions of cold-type composing machines.

a. Selecting and Setting Body Type. The basic criterion for choosing body type is legibility. This depends on the style of type, its size, the length of the lines and the spacing between them, the indentations, the margins around the pages, and the spacing between words and letters.

(1) *Size and style.* Roman type faces, because they are easy to read, are the most commonly used styles for body type. The most practical sizes are 8- to 10-point, because they permit an economical number of words per page without sacrificing readability.

(2) *Length of lines.* Lines that are too long or too short are undesirable; both are tiring to the eye of the reader. A good rule of thumb is to set the pica length of the line to twice the point size of the type if the copy is set solid. The lines may be set a little longer if the copy is leaded.

(3) *Spacing between lines.* Two-point leads usually are used between the lines of most body type. Smaller type faces, however, need less leading; too much space between the lines weakens the copy and makes it difficult to read. Leading should be used to achieve tone and legibility. It should never be used to space out the type to fit the page.

(4) *Spacing between words.* The spaces which separate words in a line of type should be limited to about a 3-em space in most instances. Too much space between words causes a disturbing break in the composition, creating river-like areas of white space. Spacing must sometimes be

varied slightly in order to "justify" the lines of type, that is, to make them all of even length. Modern typesetting equipment usually justifies type automatically.

(5) *Indentations.* The size of indentations for paragraphs usually is based on the length of the line and the size of the type. The smaller indentations are used for the shorter lines, or for the larger type faces.

(6) *Margins.* On single pages, the right and left margins should be even, but the bottom margin, to avoid monotony, should be slightly larger than the top margin. In bookwork, the inner margin of the page is often made narrower than the other, so that when the book is opened, the white space in the center will appear to be equal to the width of the outside margins. The top margin is slightly larger than the inner margin; the outside margin is larger still, and the bottom margin is the largest.

b. Type for Display Composition. The purpose of display composition usually is to present an idea or information in a quick, easy-to-grasp form. It must gain attention, maintain interest, give information, or stimulate action. Posters, pamphlets, programs, and covers for bound publications are typical of the material requiring display composition. Type used for such printed matter must be attention-getting, as well as legible and pleasing in appearance.

(1) *Style.* Type faces reflect certain characteristics, such as refinement, dignity, boldness, strength, severity, or stability. The characteristics of any type chosen for display composition must be suitable in mood and appropriate to the purpose and nature of the copy. Type styles are often combined in display work to create interest and variety; when several type styles are used on the same copy, they should have similar and harmonious characteristics.

(2) *Size.* Variety in size improves the effectiveness of display type, the larger sizes providing emphasis for the more important ideas. It should be remembered, however, that bold type styles need not be so large as light-lined type faces to achieve the same attention-attracting effect.

(3) *Length of lines.* Contrast in the length of lines adds interest, and when combined with various sizes and styles of type, helps to emphasize the most important items.

(4) *Arrangement.* Display type often accompanies art work of various types, and becomes an integral part of the overall artistic composition, as well as a means of communication. Type as part of design is further discussed in paragraph 4–9 below.

4–8. Preparation of Art

a. General. Art work for offset printing falls into four general categories, line, tone, a combination of line and tone, and color work. Line drawings, such as those made with pen and ink, or type proofs, contain no tones or shades, only solid black and white. Tone work contains graduated shading and intermediate tones, as in photographs. A photograph to which lettering has been added is a common form of combination tone and line work. Tone work must be photographed through a halftone screen, to convert the gradations of tone into a form suitable for offset lithographing. Line work is copied without the use of a screen. For combination work, therefore, tone and line art must be separated for the camera phase, to be recombined when the press plate is made. Separate press plates must be made for each color in multicolor work.

b. Line Copy.

(1) Line drawings should be prepared, if possible, on white paper with black india ink. Colored inks or colored backgrounds should be avoided because they frequently reproduce poorly, causing difficulties for the camera man.

(2) The quality of an inked drawing is improved if it is reduced slightly from its original size when the negative is made. This reduction minimizes flaws and defects. The linework must be clear, sharp, and open to prevent a closing up of detail when the reduction is made. Enlargements should be avoided if possible, since they tend to exaggerate small flaws.

(3) When a series of illustrations will be used for the same publication, they should be prepared at the same scale, if possible. This will save much time and work for the cameraman by permitting all the art work to be copied with the same camera setting.

(4) Shaded effects can be achieved on line work by special drawing techniques, such as crosshatching with pen and ink, or by using special patterns printed on clear, waxed-back acetate, which can be trimmed to fit the required space and shape, and pressed into place.

c. Tone Copy. Most tone copy consists of photographs, but it can also include drawings ren-

dered in pencil, crayon, charcoal, wash, watercolor, tempera, oil, and airbrush.

(1) Besides the black and white areas found in line work, tone copy also has many shades of gray. These varying shades must be converted into a form suitable for offset printing. The cameraman does this by photographing the copy through a *halftone screen*, made up of a series of fine crosslines. These crosslines break up the light as it passes through the camera, causing it to register on the film as a series of small, individual dots, each differing in size according to the amount of light reflected from the copy at that particular point. When printed, these dots blend together visually, to appear as a series of tones ranging from pale gray to black.

(2) Photographs must often be retouched to bring out important details, to paint out unwanted information, or to improve the contrast between dark and light tones. Retouching usually is done with a watercolor brush and special retouching watercolors, which range from white, through seven shades of gray, to black. If the equipment and skilled personnel are available, airbrush techniques may also be used for retouching photographs.

(3) Photographs are often improved by omitting unessential detail surrounding the subject which may distract the viewer's attention. Areas to be cropped by the cameraman may be indicated in various ways. Crop marks may be inked or penciled in the margins of the photograph, the desired area may be outlined in chinese white or other removable watercolor, or the unwanted portion of a picture may be covered with a paper mask.

d. Combination Art. Combination art consists of both tone and line copy, as when lettering or solid outlines overprint part of a photograph. The tonal part of the art must be halftone screened, and is mounted separately on stiff cardboard. An acetate overlay is securely fastened over the mounted photograph, and the solid detail is pasted or inked in its desired position on the overlay. Registration marks, usually crossticks, are shown outside the work limits on both pieces of copy, as are all necessary identifications and size information. Separate negatives made from the photograph and the overlay in the camera phase are recombined when the printing plate is processed.

e. Color Work. The amount of color printing by military units other than topographic is very limited. When color work is necessary, there are several methods of color separation commonly used.

(1) A simple black-and-white drawing is sufficient if the colors do not overlap each other. A tissue overlay indicating the desired colors is prepared as a guide for the cameraman, who performs the necessary color separation by making a series of negatives. As each negative is shot, all detail except that to print in the desired color is masked out on the copy. A separate press plate is made for each color.

(2) If colors overlap, they cannot be separated by masking, and must be shown on separate copy. The basic detail, usually that which will print black, is dawn and mounted on stiff cardboard. Each remaining color is shown on a separate acetate overlay, keyed to the basic drawing and identified as to color and figure number.

(3) Process color reproduction, a third form of color separation, is entirely a camera function, and is used when tone copy is to be reproduced in color. In process color work, the cameraman separates the colors photographically by the use of appropriate filter and film combinations (para 5–13). Such copy needs no prior processing by copy preparation personnel, other than mounting and scaling.

4–9. Arrangement and Design

a. General. Any printing job which consists of more than one element on a given page must be composed and arranged. Sometimes the format is prescribed by regulations or by specifications prepared by the originating element. In such cases, the military reproduction element conforms to instructions, performing only those mechanical tasks necessary to print an acceptable photolithographed product. In certain nonstandard printing projects, however, the reproduction element may be responsible for designing the format of the copy before it reaches the camera phase of the photolithographic process.

b. Grouping of Elements. As many as possible of the components that make up a given page or unit of a printing job should be assembled, arranged, and pasted up into a layout for the cameraman. All line work to be reproduced at the same camera setting can appear on the same pasteup, but copy requiring halftone screening, or reduction or enlargement, must be submitted separately. In selecting an effective arrangement of the various elements which comprise the copy, there are certain aspects of good design which must not be overlooked. The arrangement should balance, proportion, contrast, and harmony,

(1) *Balance.* If the intent of the copy is formal and dignified, a symmetrical, centered, evenly balanced arrangement usually is most appropriate. Such design is static in quality and serious in mood. Off-centered arrangements create excitement, adding motion and a sense of freedom to copy of a more informal nature. Proper balance, however, is just as necessary when the arrangement is asymmetric. Figure 4–1 compares formal and informal copy. A properly balanced design, whether formal or informal, is controlled by the size and shape of the elements, their tone (lightness or boldness), and their placement with relation to the optical center. The optical center, which is where the eye normally strikes the page, is about two-fifths of the distance from the top, and slightly to the left of the actual center. Any element placed in the exact center of the page will appear to be below the center (fig. 4–2). For this reason, a design which forms an inverted pyramid is preferable to one which places more of the copy below the optical center. Blocks of type may be balanced against illustrations, or against areas of white space to achieve a visually pleasing effect. The movement of the eye can be controlled by arranging blocks of type and illustrations to lead from one to another; a carefully balanced design can be spoiled if one of the elements leads the eye out of the design instead of into it. Arrows, leading lines, pictures of people or animals, should all lead or face into a design and not out of it.

(2) *Proportion.* Many factors influence the proportions (relation of length to width) of a piece of copy. If the size of the finished product is not prescribed by regulations, the planner must consider the size of the paper stock available, the size of the press plate, and the capacity of the binding equipment. A size that can be cut out of stock sheets with the least amount of waste is desirable. Besides these practical considerations, there are other guidelines in choosing a well-proportioned shape and size for the copy. Certain rectangular forms with specific dimensions have proven to be more interesting, and therefore more popular, than others. Among these are the Printer's Rectangle, with a length approximately 1.5 times its width (a ratio of 2:3); the Golden Mean Rectangle, whose length is about 1.6 times its width (a ratio of 5:8); and the Hypotenuse Rectangle, whose length is about 1.4 times its width (a ratio of 5:7) (fig. 4–3). The various elements of a design, such as blocks of type, pictures, and areas of white space, should also follow these general proportions. Two main elements that are the same size and shape will be uninteresting to the viewer; the design is improved when their sizes are varied. However, the size of one element should never be a simple multiple of another. This principle applies to the white space around the components of a design, as well as to the components themselves.

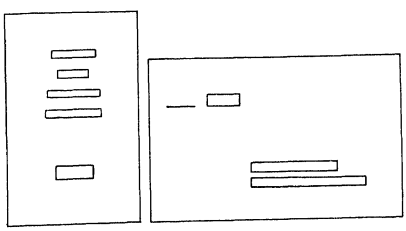


Figure 4–1. Formal and informal design.

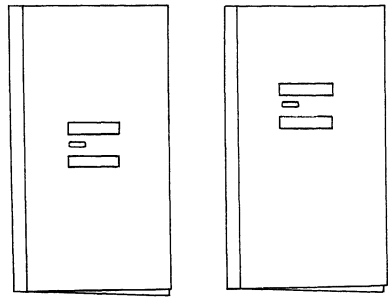


Figure 4–2. Actual and optical centers.

(3) *Contrast.* Contrast is an effective means of emphasizing the important elements in a design, and avoiding a dull, monotonous appearance. Large type faces may be contrasted with small; lightline with bold face; or italics with upright. Variety in the length of lines, as well as in sizes and styles, adds both interest and emphasis. Related lines of type may be grouped together, and these blocks of type contrasted with illustrations or areas of white space.

(4) *Harmony.* After proper balance, pleasing proportions, and effective contrast are achieved in a design, the copy preparer must assure that all its components are harmonious. Each element chosen, and the way it is arranged, must be appropriate to the mood and purpose of the copy. No one element should be permitted to conflict with another, or with the mood of the composition. Variety and contrast need not be sacrificed to achieve

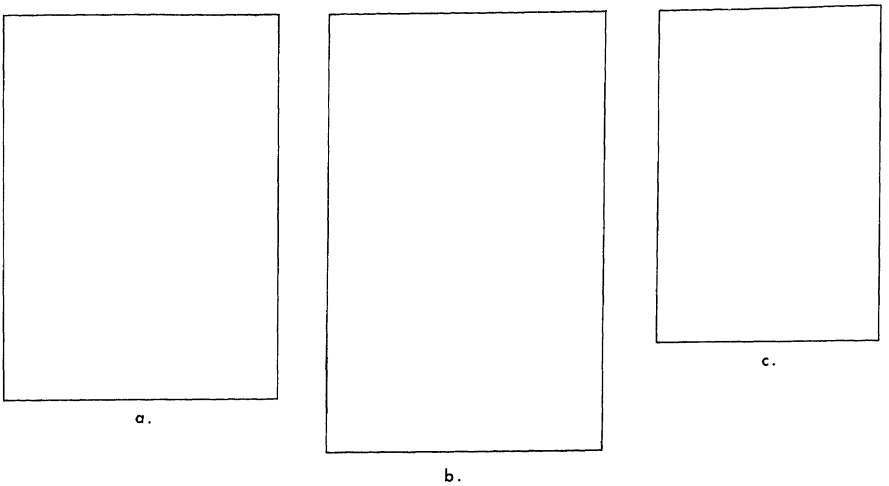


Figure 4-3. Commonly used rectangles: a. Printer's; b. Golden Mean; c. Hypotenuse.

harmony; many different type faces, border trims, and types of art go together very effectively.

4-10. Assembling the Copy

a. General. Before copy is sent to the camera section, it should be assembled, identified, and scaled, and all necessary instructions clearly indicated. The copy preparer should remember at all times that the purpose of the camera phase is to convert his copy into final reproduction negatives, to be used in making the press plate. Consequently, it is essential that the cameraman know exactly what is intended.

b. Preparing the Paste-Up. As much of the final copy as possible is pasted on a layout in its exact position. Everything on one pasteup must be shot at the same scale and with the same camera assembly, and will appear on the same negative to print in the same color. Therefore, any tone copy, whether it is a drawing or a photograph, that requires screening should not be pasted up with line copy. Any material to be changed in size or to print in another color must also be separately photographed.

(1) Any guidelines or notations which should not be reproduced are lightly pencilled in non-photographic blue. When possible all such notations are made outside the work limits of the copy.

(2) The exact position intended for material being separately photographed is clearly indicated by inked outlines and an identifying code. This area will be cut out of the finished negative and a negative of the appropriate copy, correctly screened or scaled, will be mortised, that is, fastened in place with special clear red tape. Another method is to paste pieces of black paper, cut to the exact size and shape of the photographed art, in their correct positions on the paste-up. These will photograph as clear areas on the negative, making it possible to tape the photographed art into position without cutting windows into the negative. The problem of indicating where each strip-in belongs can be solved by preparing a mock-up on which each strip-in is identified and positioned.

(3) All copy prepared for the camera phase should be clean and neat. Fingermarks, smudges, bits of rubber cement and any other dirt will photograph, necessitiating much time-consuming opaquing of the negative. Type proofs should be carefully examined and any imperfect letters touched up with india ink or chinese white watercolor.

c. Preparing Art for Reproduction. All copy submitted separately with the paste-up is carefully mounted, scaled, cropped, if necessary, and identified.

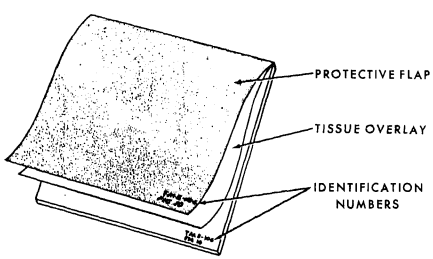
(1) *Mounting.* Heavyweight artist's mounting board, illustration board, or other stiff cardboard is used for mounting. Dry-mounting equipment is preferable if it is available; rubber cement is also acceptable. The copy should be securely mounted and perfectly flat. Sufficient margin should be left on all four sides of the illustration for notations such as instructions pertaining to cropping, scaling, or identifications. The top of the copy is always indicated. A tissue overlay and a protective flap of heavy kraft paper is taped to the rear top edge of the mounting board and folded over to protect the face of the copy (fig. 4–4).

(2) *Cropping.* If only a portion of a drawing or photograph is to be used, the unwanted areas to be cropped are clearly indicated in the margins by pencilled marks at each of the four corners (fig. 4–5). Never mark with pencil or ink directly on the photograph. Another method uses chinese white watercolor, or other removable paint, on glossy photographs to outline the areas to be reproduced. If the copy is a matte-finished photograph, or a drawing, a paper mask exposing only the desired area may be positioned over the copy and fastened in place.

(3) *Scaling.* The desired size in picas is clearly noted in the lower margin, usually between the crop marks, and preferably for the entire horizontal dimension (fig. 4–5). It is important to remember that the change in the vertical dimension will be in proportion to that in the horizontal. The new height should be calculated carefully to insure that the reduced or enlarged copy will fit correctly into the space reserved for it.

(*a*) With the desired width known, the new height can be computed by using the simple formula for proportions:

$$\frac{\text{original width}}{\text{new width}} = \frac{\text{original height}}{\text{new height}}$$



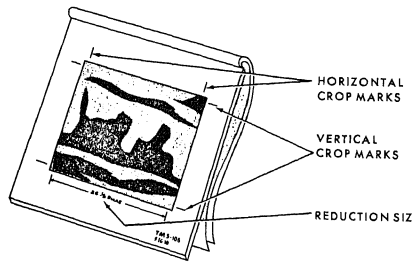
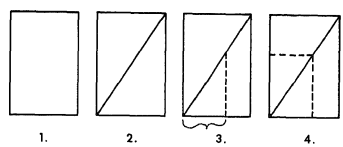


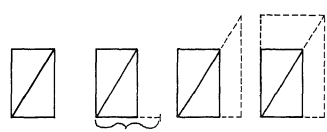
Figure 4–5. Cropping and scaling of art work.

(*b*) The desired new dimensions may also be determined graphically by drawing a diagonal from the lower left corner to the upper right corner of a rectangle the exact size of the copy; measuring the exact width on the bottom line (or an extension of it); drawing a perpendicular line from the measured width to the diagonal (or an extension of it); and completing the new rectan-



1. DRAW RECTANGLE THE EXACT SIZE OF COPY.
2. DRAW DIAGONAL FROM LOWER LEFT TO UPPER RIGHT CORNERS.
3. MEASURE DESIRED WIDTH FROM LOWER LEFT CORNER ALONG BOTTOM LINE AND DRAW PERPENDICULAR LINE TO DIAGONAL.
4. COMPLETE RECTANGLE. THIS IS AREA OF REDUCED COPY.

Figure 4–6. Scaling for reduction.



1. DRAW RECTANGLE THE EXACT SIZE OF COPY AND DRAW DIAGONAL FROM LOWER LEFT TO UPPER RIGHT CORNERS.
2. MEASURE DESIRED WIDTH ALONG BOTTOM LINE, EXTENDING IT TO NEW MEASUREMENT.
3. DRAW PERPENDICULAR FROM EXTENDED LINE, AND EXTEND DIAGONAL TO MEET IT.
4. COMPLETE RECTANGLE. THIS IS AREA OF ENLARGED COPY.

gle. This will indicate the exact proportions of the reduced or enlarged copy (fig. 4–6 and 4–7).

(*c*) Scaling may also be done with a slide rule, a scaling wheel, or any of numerous other devices available. If no change is required, mark the copy "same size."

(4) *Identifications and instructions.* In the lower right corner of both mount and flap, each piece of art is identified both by job or publication number and with the figure number or other coded identification for the specific piece of copy. Any special instructions for unusual handling are clearly indicated in the margin, and each piece of art is marked "halftone" or "line", as appropriate. If there are overlays, as in color work, the intended color and any screening instructions, as well as the other identifications, are noted in the margin of each overlay.

CHAPTER 5
PROCESS PHOTOGRAPHY

Section I. BACKGROUND

5-1. Introduction

In the process photography phase of the photolithographic process, the graphic material produced in the copy preparation unit is used to prepare accurately scaled, undistorted photographic copies, usually negative in form, which can be used in making the lithographic plate. The basic equipment necessary for a properly functioning camera section is a process or copying camera with suitable lighting and a darkroom with film processing chemicals and equipment where the exposed film can be developed, fixed, washed and dried.

5-2. Camera Elements and Camera Types

a. Principles. In its simplest form, the camera is merely a box from which all light has been excluded except that passing through a small opening at the front. The amount of these light rays allowed to enter the camera is controlled by a device similar to the iris of the eye, called a *diaphragm*, and the duration of the exposure, by a mechanical blade or curtain called a *shutter*, which opens and closes automatically. During the time the shutter is open, the light reflected from the subject passes into the camera through a piece of optical glass called the *lens*. The lens focuses or projects the light rays onto the wall, the *focal plane*, at the back of the camera. These light reflections can be captured on sensitized material, *film*, attached to this wall.

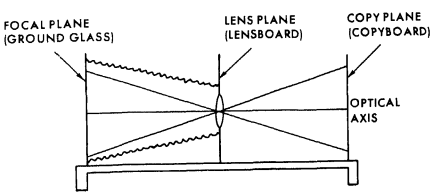


Figure 5-1. Diagram of a process camera.

b. Components of Process Camera. In the process camera, the copyboard which holds the material to be photographed and the back of the camera which holds the film are parallel planes at right angles to the optical axis which passes through the center of the lens, which lies between them (fig. 5-1). The focal plane is encased in a housing to which are attached the focusing screen (ground glass), the film holder, and the halftone screen housing. The copy is held in place by a suction device, or under glass in a pressure frame. The lens is maintained in proper relation to the other two planes on its own independent support. The three units are mounted on a chassis which provides a means for adjusting the distances between lens, film, and copy for reducing or enlarging the image, and also for maintaining the parallelism between the three essential planes.

c. Types of Darkroom Process Cameras. Darkroom cameras are so-called because the rear of the camera extends into, and is operated from the darkroom making it possible to perform both camera and darkroom operations at the same time. There are a number of variations in the installation of these cameras with relation to the darkroom, as illustrated in figure 5-2. The vertical camera, (a, fig. 5-2), is located entirely within the darkroom and requires the least space for its installation. The advantage of compact size, however, is offset by limitations in the size of film and copy it can handle, and in the range of reduction and enlargement. The most widely used type of camera in military printing plants is the horizontal darkroom camera with movable lensboard and copyboard, as illustrated in b, figure 5-2. The 24- x 30-inch mobile process camera with attached arc lamps (fig. 5-3), used by Army topographic units, is this type of camera. The overhead darkroom camera, (e, fig. 5-2) is also widely used where mobility of equipment is not required. These cameras can handle larger size film and copy, for use in conjunction with the larger sizes of press.

d. Types of Illumination. There are many kinds

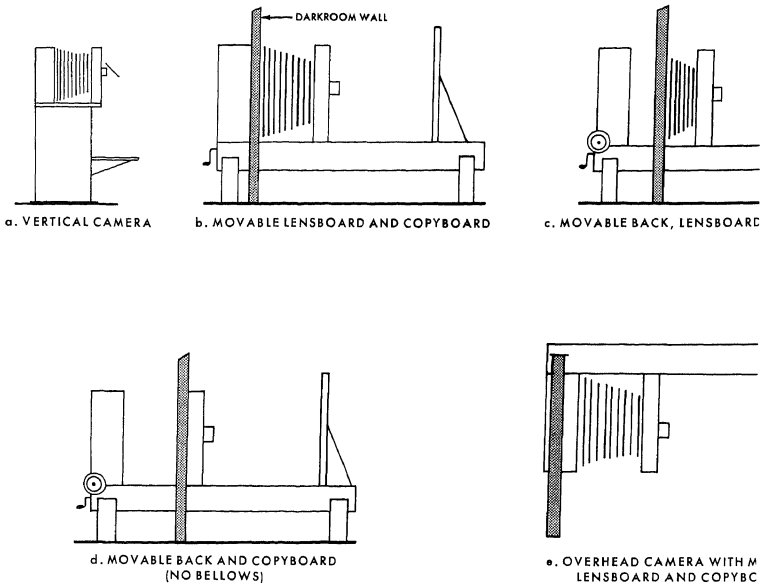


Figure 5-2. Types of darkroom cameras.

of light sources for process cameras in use today. The most common type of lamp is the carbon arc, but pulsed zenon, nitrogen-filled tungsten, and other types of lamps may also be found in military printing plants. In this manual, all references to sources of light are to carbon arc lamps. The military cameraman should follow the manufacturer's operation instructions for any other light equipment issued. Regardless of the type of light source used, the action of the light in the photographic process remains the same.

5-3. Types of Negatives

As was noted in paragraph 4-8, copy being prepared for process photography is basically one of two types, line or tone. Process negatives prepared from this copy are classed as line, continuous tone and halftone. Figure 5-4 illustrates reproductions made from the three kinds of negatives.

a. A line negative is a piece of photographic film on which the image of a line drawing has been exposed and developed. The negative consists entirely of either opaque background or clear lines. Line negatives are suitable for lithographic printing because the lines and symbols sharp, and well defined and they di tive (and subsequent plate) into de and nonprinting areas.

b. A continuous-tone negative is tones are repesented by continuous shades of gray. These negatives ar contact or projection printing, but graphic printing, because the sensi the plate receive ink uniformly on therefore cannot reproduce shades o photographs are made from continu tives.

c. A halftone negative produces the gray tones of continuous-tone co tern of dots of varying sizes. Thes reproduced by a lithographic pres effect, they are line copy, each dot bec ceptive after exposure and developm sitized lithographic plate. The patt formed by exposing the film to t through a halftone screen. This ca tones of the copy to reproduce as

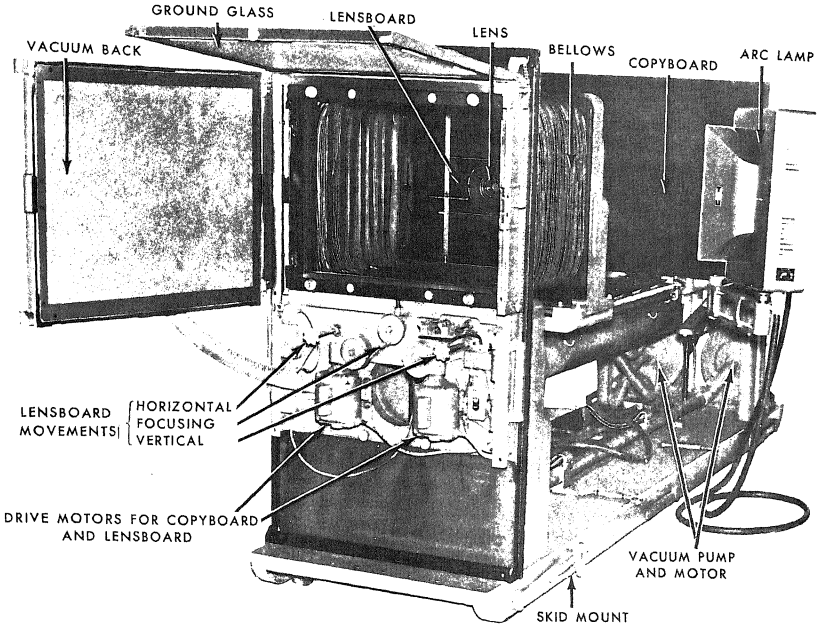
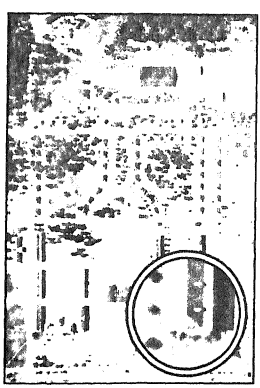
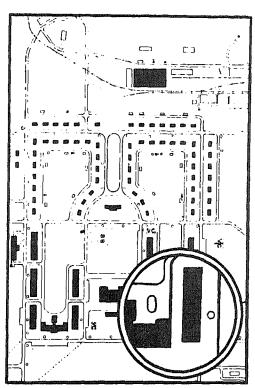


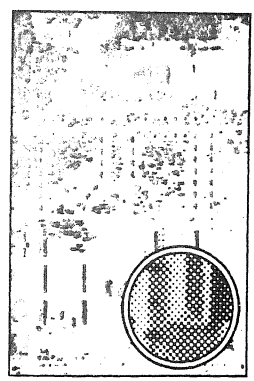
Figure 5–3. 24 × 30-inch mobile process camera.



CONTINUOUS TONE



LINE



HALF-TONE

larger dots in the darker tone areas. The finer the screen, the more detail and variations in tone that will be retained from the original copy.

5–4. Safety

a. Camera Operation. To avoid injury to personnel and damage to equipment, the following safety precautions must always be observed during camera operation.

(1) Avoid looking at arc lamps when they are lit, as serious damage to the eyes can occur.

(2) Avoid trying to remove carbons from arc lamps when they are hot or warm, as serious burns may result. Wait until the carbons cool.

(3) Do not leave old carbons inside the arc lamp housing or ash tray. Shock to the operator or damage to the arc lamp may result if carbon stubs are left in the lower section of the chamber.

(4) If carbons in arc lamps transmit excessive heat, check for deficiencies.

(5) Continuous checking of the arc lamp carbons for dampness is necessary as dampness causes overheating when the lamp is in operation.

(6) Keep the camera lens capped or in the lens box when not in use. Avoid touching the surface of the lens.

(7) Keep all accessory equipment beyond the swinging radius of the focusing glass and vacuum back.

(8) Always keep the camera rail free of tools and equipment to permit movement of the copyboard and lensboard.

b. Darkroom operations. Many of the chemicals used in photolithographic work are skin irritants and others may cause more serious injuries. All chemicals should be regarded as poisons and handled with caution.

(1) *Cleanliness and ventilation.* To avoid contamination of solutions, corrosion of equipment, and undesirable effect of chemicals on the film, cleanliness is an absolute necessity both in the darkroom and in the chemical mixing areas. Proper ventilation of these areas is also necessary to prevent the breathing of harmful and dangerous fumes.

(2) *Avoidance of electric shock.* Care must be taken to avoid electric shock when working with liquids. Do not touch electric lines, connections or switches with wet hands or when standing on a wet or damp floor.

(3) *Avoidance of chemical burns.* Both acids and alkalis can cause severe skin burns. Use protective gear, such as rubber gloves, rubber aprons, and goggles while handling acid and alkali chemicals. If any of these chemicals should be accidentally splashed on the skin, wash the affected area with copious amounts of clean water. If the chemical is an acid, follow with a weak alkaline solution, such as bicarbonate of soda. If the chemical is an alkali, use a weak acid, such as acetic acid diluted one part to 32 parts of water. Wash again, after the neutralizing treatment, with plenty of clean water.

(4) *Proper chemical mixing procedures.* The mixing instructions included with photographic chemicals must be strictly followed. The order in which the chemicals are mixed and the temperature of the mixing solution are extremely important. Overmixing can cause excessive oxidation and should be avoided. Storage containers for mixed chemicals must provide protection from light and air, and must be carefully labeled and dated. When mixing and handling chemicals, *never pour water into chemicals;* pour the chemicals slowly into the water, stirring continuously. Pouring water into a strong acid or alkali can cause the solution to boil violently, causing serious burns if it splatters on the skin.

Section II. 24- X 30-INCH MOBILE PROCESS COPYING CAMERA

5–5. General

Military photolithographers are expected to work with many different makes of cameras. Basically, the main components of all copy cameras have the same functions, although they may differ mechanically. This section discusses the 24- x 30-inch mobile process copying camera, which is used in the camera van of Army topographic reproduction units, and is typical of cameras of this type. TM 5–6007 contains detailed instructions for the operation and maintenance of this camera; similar operation-and-maintenance manuals are available for other models of cameras in use in the military system.

5–6. Basic Camera Nomenclature

Part	Function of part
Copyboard	Holds opaque source material flat and parallel to the planes of the lensboard and the camera back while it is being copied. The material being copied is held flat by suction created by drawing air through holes in the copyboard.
Transparency holder	Also use suction to hold transparent materials, either negatives or film positives, flat and parallel to the planes of the lensboard and the camera back while they are being copied.
Copyboard vacuum turbo-compressor	Supplies suction to the copyboard and transparency holder.
Copyboard drive mechanism	Moves the copyboard (or the transparency holder) toward or away from the lensboard in order to permit focusing and copying at the desired scale.
Camera vacuum back	Holds the film flat during exposure by means of suction created by drawing air through the porous back of the suction plate.
Camera vacuum turbo-compressor	Supplies suction to the camera vacuum back.
Focusing glass (or ground glass)	Used for checking the scale setting and focus. After the desired settings are established for the copyboard and the lensboard in relation to the focusing glass the latter is swung out of the way and the vacuum back, with light-sensitive film mounted on it, is positioned in the plane formerly occupied by the focusing glass.
Bellows assembly	Provides a flexible, light-tight connection between the lens and the camera back.
Lens	Projects the image of the material being copied onto the light-sensitive emulsion.
Iris diaphram	Controls the size of the opening through which light from the material being copied passes.
Shutter	Controls the length of time during which light from the material being copied passes through the lens.
Lensboard drive mechanism	Moves the lensboard toward or away from the copyboard and the film plane in order to permit focusing and copying at the desired scale.
Arc lamps	Supply light of the proper intensity to illuminate the copyboard. They operate with the aid of a transformer and a magnetic contactor.
Camera tube	A horizontal, structural part of the overall assembly which supports the lensboard, the copyboard and the transparency holder.
Skid platform	A sturdy base on which the camera is mounted. Used to install the camera rapidly in a mobile unit.

5–7. Copyboard Assembly

The copyboard assembly consists of three basic parts—the copyboard, the transparency holder, and the vacuum turbocompressor and hose. These units are treated separately in the following paragraphs.

a. Copyboard. The copyboard is capable of holding original copy up to 36 x 48 inches in size. It is mounted on the axle and tube assembly by two hand knobs which are part of the copyboard locking devices. The locking devices fit into the slots of the copyboard flange, holding the copyboard secure. The flange is bolted to the copyboard, providing a rigid interconnection of the assemblies. The front surface of the copyboard assembly contains a series of inlet holes systematically arranged to hold copy of specified sizes. The copyboard vacuum operating knob on the back of the copyboard controls the suction area of the assembly. Copy is held flat on the copyboard by vacuum formed when air is exhausted from the frame through the holes in the front surface of the copyboard.

b. Transparency Holder. The 22- x 28-inch transparency holder is capable of holding original

transparent copy up to 21½ x 27 inches in size or a roll of film on a spool up to 18¾ inches in width. The face of the holder is a $\frac{5}{16}$-inch polished plate-glass diffuser which covers an inner glass diffuser of equal size. The top and bottom sections of the transparency holder are identically equipped with a slide bar to hold the aerial film brackets. The inside of the holder consists of a lightbox assembly which is, in itself, an independent unit which can be removed. The transparency holder has internal air passages with corner openings in the glass diffusers. Film to be copied is placed near the center of the glass and covered with a piece of clear plastic which is large enough to extend out to the corner openings. When the diverter knob is pulled out the suction pulls the clear sheet of plastic flat against the glass and flattens the film being copied. The bank of fluorescent lamps illuminating the transparency holder is controlled by an off-on light switch mounted on the copyboard frame.

c. Copyboard Vacuum Turbocompressor and Hose. The turbocompressor assembly has a 1-horsepower motor attached to its housing frame. It is provided with a flexible rubber hose extending from the rear side of the compressor to the transparency holder and copyboard. The control switch for the copyboard vacuum turbocompressor is a two-element, pusbutton, off-on switch, located on the copyboard frame, which starts and stops operation of the turbocompressor.

5–8. Arc Lamps

a. Description. The copyboard is illuminated by two constant-intensity carbon arc lamps which provide light over the entire area. The arc lamps are mounted on arm brackets which are coupled to the copyboard assembly to maintain a uniform intensity of illumination regardless of the position of the copyboard along the camera ways. Housed within the arc lamp reflector are two carbons of different intensity ratings. The top carbon is of high intensity, and the bottom carbon is of low intensity. The reason for high- and low-intensity carbon rods is to make the upper and lower rods burn at the same speed without flickering. The spacing between the rods is controlled by electronic sensing devices. The 50-ampere arc lamps operate on 110 volts ac through a single-phase transformer and a magnetic contactor. The arc lamps are controlled by one pushbutton switch inside the darkroom and another on the lensboard. *Do not look at the arc lamps during operation!* To prevent eye injury wear goggles.

b. Positioning Arc Lamps. The arc lamps normally are set at a 45° angle to the copyboard for best illumination of the material being copied. However, within the restricted area of the process camera section van, the lamps cannot be swung that far out. In this situation the outermost position for the lamp is at an angle of 36° to the camera ways (or a 54° angle to the copyboard).

c. Installing Carbon Arc Rods. The nine separate steps in installing the carbon arc rods are as follows:

(1) Turn off the trim switch located on the right front truss support approximately 1 foot off the floor. (There is no "off" or "on" indicated on the switch. For the purposes of this manual "off" means the arc lamps will *not* light when the arc lamp switch is turned on.)

(2) Turn on the arc lamp switch. This turns on the power to the light units and the rods will separate. Allow them to separate all the way. Keep cables from binding.

(3) Turn off the arc lamps.

(4) Turn off the main power.

(5) Take out the old carbons and at the same time clean out the ashes from the reflector. Replace the used carbons with new ones.

(6) Insert new carbons with the ends of the rods flush with the carbon holders. This should leave a ¾-inch gap between the carbon rods. Use No. 1012 high-intensity copper-coated carbons on the top and white flame copper-coated carbons on the bottom.

(7) Turn on the main power.

(8) Turn on the trim switch.

(9) Turn on the arc lamps and allow them to burn for at least 30 seconds before making an exposure.

5–9. Camera

The camera proper, excluding the copyboard assembly, the structural frame, and the arc lamps, consists of five basic parts—the vacuum back, the focusing glass, the glass halftone screen housing and separation mechanism, the bellows assembly, and the lensboard assembly, including the shutter —plus the controls for focusing and otherwise moving the parts of the camera and the copyboard. These units are treated separately in *a* through *f* below.

a. Vacuum Back and Vacuum Pump.

(1) The vacuum back holds the film flat during exposure. It is hinged to and supported by the

camera housing frame, and consists of a hinged door with a porous suction plate on the inner side and a vacuum back plate on the outer side. The plate has a cast aluminum vacuum back valve housing with a valve handle or knob on the back of the door for controlling the vacuum for various size films. The handle can be pointed to numbers ranging from 0 to 4. Each number is for a different size of film. The zero setting means that the openings are all closed. The number one setting creates an area of suction on the porous plate large enough to hold a 9- x 9-inch sheet of film flat. The number two setting enlarges the area of suction so that a 14- x 17-inch sheet of film will be held flat. The number three setting is for a 20- x 24-inch sheet of film and the number four setting holds flat a 24- x 30-inch sheet of film.

(2) The turbocompressor assembly has a 1-horsepower motor attached to its housing frame. An 8-foot iron pipe on the camera skid with sections of reinforced rubber hose on each end connects the vacuum back and the compressor. A flexible rubber hose through the back support plate is clamped to the vacuum back valve housing. The vacuum pump and motor require little attention other than proper lubrication. When new or cold, however, or when operating on 50-cycle current, the pump should warm up without a load for 15 minutes or longer to prevent overheating and possible burning out of the motor.

b. Focusing Glass (or Ground Glass).

(1) The focusing glass is held in its frame by six holder clips located on the sides and bottom of the frame. The grained surface of the focusing glass, which is position in the same optical plane as the film emulsion, contains a grid of photographically exposed, permanently fused lines spaced at intervals of 0.1 inch and covering the 24- x 30-inch rated area. The ground glass permits examination of the image with a magnifier for sharp focus. A clear transparent circle 1 inch in diameter is provided in the center of the grid area and conforms with the optical axis of the camera. Critical focusing is done through this clear area with the aid of the magnifier. Four circular openings, one at each corner of the focusing glass, permit measuring of the separation between the adjacent surfaces of the focusing glass and the glass halftone screen, when it is being used.

(2) Measurements on the focusing glass can be made with a beam compass. Tabs of transparent adhesive tape are placed over the points to be measured. This helps prevent the points of the compass from slipping. To eliminate the possibility of parallax errors when measuring directly with the beam compass the operator stands directly behind the image at each tab of tape, pricks the points, and then blackens each hole with graphite. In this way he can measure the distance between the two points with the beam compass in normal room light.

(3) Clean the focusing glass with a soft, clean cloth dampened with a suitable nontoxic cleaner. Wipe all surfaces thoroughly to keep the focusing glass at maximum transparency. Dry the focusing glass with a soft, dry cloth. When the camera is not in use, leave the focusing glass in the "up" position. During operation, make sure the frame is tight against the magnetic latches which are situated under the screen housing group.

c. Glass Halftone Screen Housing and Separation Mechanism. The screen housing consists of the parts required to hold the glass halftone screen, to adjust its distance from the film, and to maintain the parallel relationship to the focusing glass and vacuum back necessary for producing properly exposed halftone negatives. The screen is held by four adjustable stop knobs—two on the bottom screen bar and two on the top screen bar. The details of this mechanism are explained in paragraph 5–24, and in TM 5–6007.

d. Bellows Assembly. The bellows assembly is the rubberized fabric connecting the lensboard and the camera back. The bellows are made of heavy rubberized duck material to form a single accordion unit capable of extending the full range of reproduction settings. The ends are framed for mounting on the camera back and the lensboard. The bellows support assembly, which is attached to the camera back and supported by a roller on the lensboard, is extendable. It supports the bellows by three roller carriers. The bellows is also equipped with a strap used to hold the expandable fabric secure when the camera is prepared for transit.

e. Lensboard Assembly.

(1) *Function.* The lensboard assembly consists of the lens, the shutter assembly, and the controls used to move it toward or away from the film plane, up and down, or left and right. The lensboard is mounted on the carriage assembly by two side frames, and provides horizontal and veritical movement for the lens. Its positioning normally is controlled from the darkroom end of the camera, or by small handwheels on the front of the lensboard. The lens and the shutter assemblies are mounted on opposite sides of the frame.

(2) *Lenses.*

(*a*) There are two lenses used on the 24- x 30-inch mobile process camera—a 19-inch and a 24-inch focal length lens. The cameraman's decision to use either lens is based on the amount of reduction or enlargement planned in the copy work and the size of the copy material in relation to the copying scale. The 24-inch lens is capable of reducing an original to 50 percent of its original size or enlarging it to 200 percent. The 19-inch lens is capable of reducing an original to 33 percent and enlarging to 300 percent. The length of the camera bed prohibits the use of the 24-inch lens below 50 percent or above 200 percent. In practice, the 24-inch lens usually is used for all copy work, except for reductions below 50 percent and enlargements above 200 percent.

(*b*) For directions for mounting the 19-inch or 24-inch lenses in the Rutherford model of the 24- x 30-inch mobile copying camera, see TM 5–6007.

(3) *Care of Lenses.* There are a few simple instructions to follow in caring for lenses.

(*a*) Cap lenses and keep in storage box when not in use.

(*b*) Do *not* touch glass with fingertips.

(*c*) Protect the lens from dust, heat, and chemical corrosion while in use.

(*d*) Do not tamper with the lens nor subject it to rough handling.

(*e*) Use only an approved lens cleaner on the lens. Never oil the diaphragm or other lens parts.

(4) *Shutter assembly.* The shutter is electrically controlled and operates on 95 to 125 volts, dc. It is equipped with a power rectifier unit for converting ac to dc, and a solenoid for control. There are two switches for operating the shutter—one is in the darkroom on the back support plate of the camera, and the other is mounted on the side frame of the lensboard. Both are three-way toggle switches. The 24-inch Kodak lens also has a manually operated shutter mounted on the lens barrel between the lens elements, which can be used in lieu of the electric shutter.

f. Controls for Focusing and Moving Camera.

(1) *Motor driven controls.* These controls are used to move the copyboard and the lensboard toward or away from the film plane. On the back support plate of the camera back are two control switches, which actuate the drive motors that move the copyboard and the lensboard. The copyboard control switch is on the left and the lensboard control switch is on the right. These switches use a spring-loaded hand lever which returns to the neutral position after being released. The copyboard and the lensboard drive motors are of the same type. They move the copyboard and the lensboard along the camera ways by individual drive screws.

(2) *Manual controls.* The copyboard and lensboard have separate fine adjustment handwheels which are approximately 7 inches in diameter. The handwheels provide the necessary fine adjustment after the approximate setting has been obtained with the electric control switches. There are also manual control knobs to position the lens on the lensboard to an appropriate horizontal and vertical position.

(3) *Positioning counters.* The lensboard and copyboard have positioning counters inside and outside the darkroom. The counters indicate the appoximate location for a specific scale of reproduction. The fine adjustment is performed manually. Refer to ratio charts for the lens used for counter readings required for the desired enlargement or reduction. From within the darkroom, position the copyboard carriage to the counter reading by using the copyboard control switch. Set an approximate number above the required reading, and rotate the fine adjustment handwheel clockwise until the required number is centered in the counter window. *Always set the final reading clockwise so as to take up any play that may develop in the drive.* The lensboard setting is similarly made.

Section III. BASIC OPERATIONS

5–10. Scaling

a. Introduction. Map manuscripts are often compiled and drawn to an accuracy of thousandths of an inch, and must also be copied photographically within this tolerance. Measuring instruments are available for obtaining and holding the accuracy desired. Among these are the beam compass and the Invar scale, which are used to set and check the image size on the focusing glass before the copy negative is exposed. It is important to know how to use the beam compass and how to read the Invar scale.

b. Beam Compass. The beam compass consists of a bar 18 to 72 inches long, a fixed steel point which can be fastened wherever desired on the bar, and an adjustable needle point which, after being fastened on the bar, can be moved slowly with a thumbscrew. The beam compass is used in conjunction with the Invar scale.

c. Invar Scale. The Invar scale is made from a special steel alloy which has a low coeffiecient of expansion and, therefore, retains the same length over a wide range of temperature. The scale is kept in a special box for protection. Invar scales graduated to 0.01 inch and 0.01 centimeter are used for checking, on the focusing glass, the scale of the image of the material being copied. The size of a reproduced image can be estimated to the nearest 0.001 inch or 0.001 centimeter. One side of the Invar scale is calibrated in the metric system and the other side in the English system. The metric side measures 1 meter and the English side is approximately 39 inches. On the left end of the bar, one unit—an inch on the English side and a centimeter on the metric side—is graduated in tenths by parallel *diagonal* lines extending from bottom to top. It is further divided into hundredths by parallel lines extending throughout the length of the bar. The thousandths are *estimated* along the diagonal between the parallel hundredths lines. The measurements must be made parallel to the horizontal lines at all times. For example, if one end of the compass is on the fourth line from the bottom, the other end also is placed on the fourth line from the bottom. *The Invar scale should never be taken from its protective box.* To use the reverse side, merely close the box, turn it over, and reopen it. Use care when adjusting the points on the beam compass to a desired measurement to avoid scratching the surface of the scale. Preliminary adjustments should be made on the side of the box.

5–11. Exposure Determination

a. Introduction. Thus far in this chapter we have dealt with instructions or outlines telling what is done, the equipment with which it is done, and how it is done. In this paragraph, we shall discuss the factors which influence determination of the correct exposure, that is, how much light should pass through the lens to the film, and for how long. The variables which must be taken into consideration when estimating the best diaphragm setting and exposure time are: the type of lens; the type of film used; the scale of the reproduction; the type and intensity of lighting; the nature of the material being copied; the type of work planned, i.e., line, halftone, or continuous tone; and the need for light filters, if any. Succeeding portions of this paragraph are devoted to lens characteristics, the f/stop system (diaphragm openings), determination of a basic exposure, enlargement and reduction, compensating for variables by changing the aperture, the percent copy-size ring or bar, determining exposure with a fixed aperture setting, photosensitive materials used in the process camera sections, the manufacturer's film data sheet recommendations, and exposure meters.

b. Lens Characteristics.

(1) The lens is the eye of the camera. It receives light from the copy and projects it as an image on the focusing glass or light sensitive emulsion at the back of the camera. The process lens is color-corrected and gives a sharp, accurately proportioned image of the original copy. It has several glass elements with different refractive indexes, which are ground to specific curvatures and mounted in a fixed relation to each other, according to a mathematical formula. This formula is designed to balance each type of lens aberration or defect against the others to minimize distortion of the image. For further background information, see TM 11–401.

(2) A lens is generally classified by focal length, speed (maximum usable diaphragm aperture), and degree of correction for color and astigmatism. It may also be rated for coverage and resolving power. Focal length, speed, color correction, and serial number usually are the only data marked on the lens barrel. Other characteristics must either be obtained from the manufacturer's literature, or be determined experimentally.

(3) The focal length of a lens is the distance from the lens to the projected image *when the lens is focused on an object at infinity.* This distance is measured from a calculated point (a theoretical position on the optical axis called the nodal point) within the lens system. If the lens system has two nodal points, the focal length is measured from the rear node to the focal plane (fig. 5–5).

c. F/Stop System (Diaphragm Openings). The f/stop system was designed to give the camera operator a numerical means of controlling the amount of light reaching the film emulsion. The theory of the f/stop system is developed at length in TM 11–401. For the purposes of this chapter, it is sufficient to say that the full f/stops are a series of numbers which indicate iris diaphragm open-

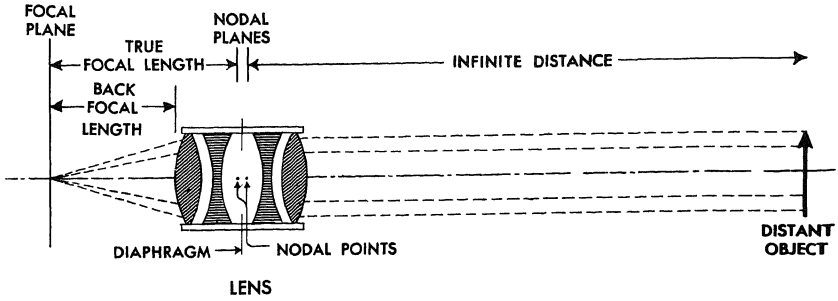


Figure 5-5. Lens characteristics.

ings that admit exactly one-half or twice as much light as the opening of the next f/number. These full f/numbers are f/1, 1.4 2, 2.8, 4, 5.6, 8, 11, 16, 22, 32, 45, 64, 90, 128, and so on. Proceeding from f/1 (the largest aperture) every succeeding smaller aperture (larger number) is found by multiplying the preceding f/number by 1.4 (the square root of 2). The control principle is simple —decrease the aperture size by one f/value and you cut the light passing through the lens by one-half; increase by one f/value and you double the amount of light. *Exposure times are related to the f/stops. The amount of exposure needed at a new f/stop varies directly as the square of the f/values. Example:* Old f/value^2: New f/value^2:: Basic Exposure Time: New Exposure Time, which is expressed in the formula:

$$\text{NET} = \frac{\text{BET x New f/value}^2}{\text{Old f/value}^2}$$

For example: If an exposure of 4 seconds produces a satisfactory negative at f/8, what exposure would be required at f/16? Substituting these values in the formula, the exposure is determined as:

$$\text{NET} = \frac{4 \times 16^2}{8^2} = \frac{4 \times 256}{64} = \frac{1024}{64} = 16 \text{ seconds}$$

d. Determining Basic Exposure.

(1) In *c* above, a new exposure time is determined through the application of a simple mathematical formula based on a basic exposure time. How is this basic exposure time determined? This is a recurring problem which must be solved because several other techniques covered in succeeding paragraphs assume that the operator has a *standard* or *basic* exposure time from which he develops a *new* exposure time.

(2) To establish a basic exposure with a given film for any copy camera, run a series of test exposures. Set the camera for a 100 percent (or 1 : 1) copy. Place the lamps at a 45° angle to the copyboard, 41 inches from its center. If working in a van, use the 54° setting. Mix fresh developer according to the manufacturer's directions and cool to a desired developing temperature of 68° F. (20°C.). Mount an original piece of copy, typical of those most often copied, on the copyboard. Along the margins of the copy, mount a 10-step reflection gray scale and several resolution targets similar to the one illustrated in figure 5-6. Make a series of test exposures at f/32 and develop for the recommended time in the freshly mixed standard developer. If the lighting setup is like the one described on the data sheet from the

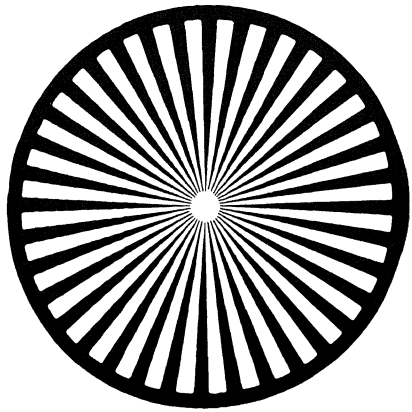


Figure 5-6. Resolution target.

film box, use the exposure listed on the data sheet as a starting point for the spaced test exposures. For example: if the data sheet gives a normal exposure of 13 seconds at f/32, make exposures at 7, 10, 13, 16, and 19 seconds. If the best negative is made at say, 19 seconds, you may need other exposures more closely related, such as 17, 18, 20, 21, and 22 seconds. Try to get as nearly perfect an exposure as possible. When you have established the *basic exposure*, record the conditions of the exposure as a guide for film use.

e. Enlargements and Reductions. When making a same size (1 : 1, or 100 percent) copy, the lens is positioned midway between the copyboard and the film plane of the camera (fig. 5–7). At no other setting for either enlargements or reductions are the copyboard and film plane as close to each other as they are for a 1 : 1 copy. In the production of either reductions or enlargements, the copyboard is moved away from the film plane. As for the lens, it is moved farther away from the film plane for enlargements and brought closer for reductions. This means that when an *enlargement* is being made, the intensity of the light falling on the film plane is *less* after passing through the length of the extended bellows enclosure. When a *reduction* copy is made, the bellows are contracted and the intensity of the light falling on the film plane is *greater* than when the camera is set for a 1 : 1 copy. This was expressed by Newton in the Law of Inverse Squares, which states that the light intensity varies inversely as the square of the distance from the light source. In figure 5–8, it is clear that when copy is enlarged 4 times (or 400%), the intensity of the light is one-sixteenth that of a 1 to 1, or 100 percent exposure at the same aperture and speed. The size of the lens diaphragm opening, and the length of the exposure time, control the amount of light allowed to pass through the lens. Thus, correctly exposed negatives for enlargements or reductions require either different diaphragm openings or different exposure times from those for same size (1 : 1) reproductions. Most commercial control systems operate on the principle of varying the diaphragm opening. Table 5–1 shows the change of diaphragm openings (stops) necessary to make various enlargements and reductions *while maintaining a constant exposure time.*

Table 5–1. Change of Diaphragm Openings for Constant Exposure Times

Size of reproduction	¼	½	¾	Same size	1½	2	3
Corresponding stop No.	f/51	f/43	f/37	f/32	f/26	f/21	f/16

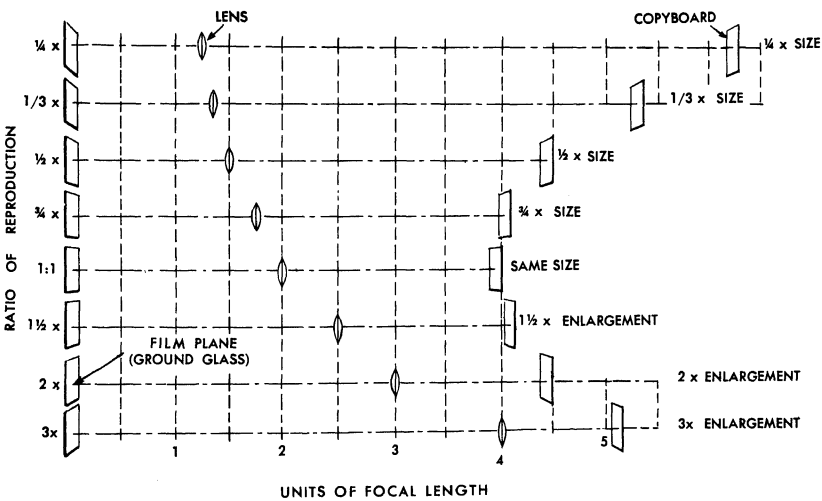


Figure 5–7. Camera component positions.

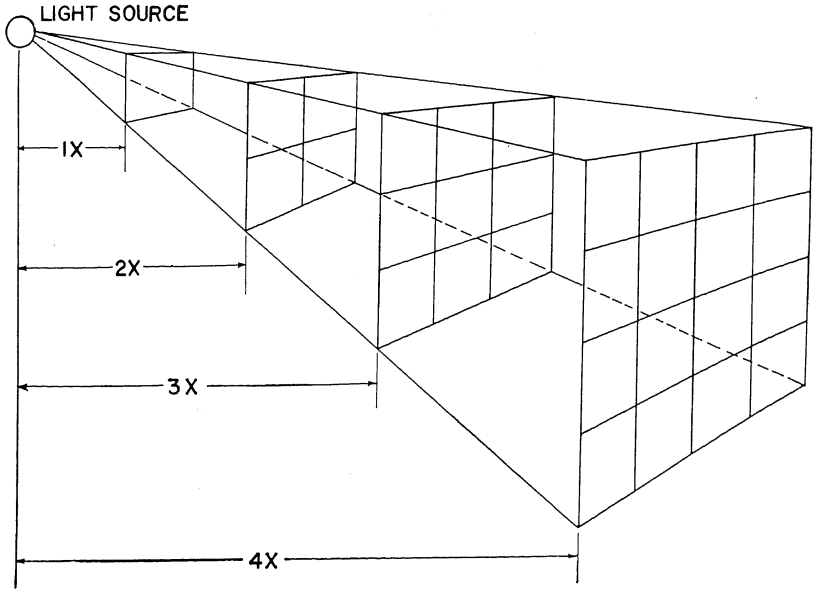


Figure 5–8. Newton's law of inverse squares.

f. Compensating for Changes in Scale of Reproduction by Changing Aperture (Percent Copy Size Ring or Bar).

(1) *The 24-inch Kodak Ektar process lens (ring type).*

(*a*) If the scale of reproduction is the only variable factor, adjusting the aperture to compensate for the change in light values is quick and easy and can be done without sacrificing definition (fig. 5–9 and 5–10). (The 19-in. and 24-in. Goerz-Lanston lenses used on the Lanston model of the mobile copying camera have similar percent copy size rings.) The upper ring, with the numbers 10, 11, 16, 22, and so on is the aperture number ring. When this ring is rotated,the diaphragm opens or closes. The middle ring is the percent copy size ring. This ring is loose; that is, turning it does not affect the diaphragm setting. The bottom ring is fixed. It cannot be rotated. The triangle marked on this ring is the f/stop indicator. The point on the top ring, opposite the triangle, indicates the f/stop of the diaphragm opening. For easier reading of the f/stops (at same size reproduction only), the diamond-shaped indicator on the middle ring may be moved so that its bottom point touches the point on the triangle and the upper point indicates the f/stop value. In the case of 1, figure 5–10, f/32 is the aperture setting.

(*b*) To compensate for the exposure change

Figure 5–9. Kodak 24-inch Ektar process lens showing the percent copy size ring.

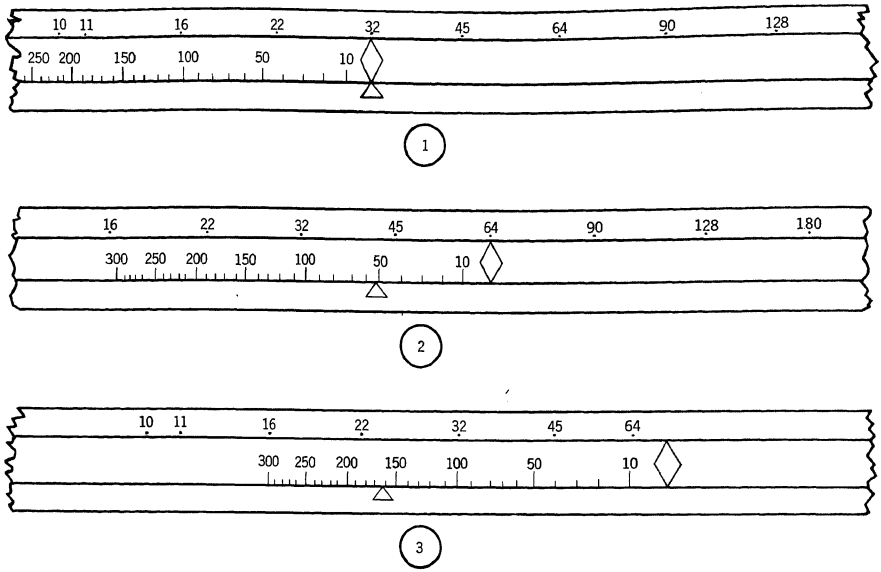


Figure 5–10. Percent copy size ring.

for scales of reproduction (SR) other than 100 percent, move the percent copy size ring so that the f/stop indicator points to the percentage desired. Set the desired f/stop over the "100" on the copy size ring. Then *move both of the movable rings together* until the desired percentage on the percent copy size ring is in line with the triangle. Two (2), figure 5–10, shows the setting for a 50 percent copy which will adjust the aperture so that the *time* of exposure can remain the same as though the original were being copied at 100 percent at f/32.

(*c*) If 160 percent is the desired scale of reproduction, 3, figure 5–10, shows the setting which will adjust the aperture so that the *time* of exposure can remain the same as though the original were being copied at 100 percent at f/32.

(2) *19-inch Goerz-Artar lens (bar-type).*

(*a*) The 19-inch Goerz-Artar lens has a percent copy size plate on the side of the lens barrel and a movable indicator scale which, as it is moved, opens or closes the diaphragm aperture. On figure 5–11, note the graduated scale indicating f/stops at the tottom of the plate. If f/22 has been chosen as the basic f/stop for a 100 percent copy, slide the movable scale so that its left edge sits simultaneously on f/22 on the bottom scale and on 100 on the second of the other graduated scales. To change the aperture setting for a 60

Figure 5–11. Aperture scale of reproduction system on 19-inch Goerz-Artar lens.

percent copy, slide the scale to the right until the edge of the scale rests on the 60 on the same scale (the second). This will adjust the aperture so that the *time* of exposure can remain the same as though the original were being copied at 100 percent at f/22.

(*b*) If 160 percent is the desired scale of reproduction, slide the scale to the left until its edge rests on 160. This will adjust the aperture so that the *time* of exposure can remain the same as though the original were being copied at 100 percent at f/22.

(*c*) The remaining graduated scales marked on the plate are used when the basic exposure is based on an f/stop setting of f/19, f/25, f/32, f/45, or f/64.

g. Determining Exposures With Fixed Aperture Setting. Some photographers always use the aperture giving maximum definition and *vary the exposure time* to compensate for a change in scale of reproduction. Table 5-2 shows the procedure for making an exposure chart. Determine a basic exposure as outlined in *d* above and multiply by the factor listed under the heading "Index" in the table for each SR to prepare an exposure chart. A table such as this is useful when maximum definition is desired and a fixed aperture is used. It eliminates the necessity for adjusting the aperture and percent copy size ring for each change in SR.

Table 5-2. Exposure for a Fixed Aperture

SR	Index	SR	Index	SR	Index	SR	Index	SR	Index	SR	Index
.30	.423	.80	.810	1.25	1.266	1.70	1.823	2.15	2.481	2.60	3.240
.35	.456	.85	.856	1.30	1.323	1.75	1.891	2.20	2.560	2.65	3.331
.40	.490	.90	.900	1.35	1.381	1.80	1.960	2.25	2.641	2.70	3.425
.45	.526	.95	.950	1.40	1.440	1.85	2.031	2.30	2.723	2.75	3.516
.50	.563	1.00	1.000	1.45	1.501	1.90	2.103	2.35	2.806	2.80	3.610
.55	.601	1.05	1.050	1.50	1.563	1.95	2.161	2.40	2.890	2.85	3.706
.60	.640	1.10	1.100	1.55	1.626	2.00	2.250	2.45	2.976	2.90	3.803
.65	.681	1.15	1.150	1.60	1.690	2.05	2.326	2.50	3.063	2.95	3.901
.70	.723	1.20	1.210	1.65	1.756	2.10	2.403	2.55	3.151	3.00	4.000
.75	.766										

Example: Exposure chart. Basic exposure—20 seconds; scale of reproduction (SR) 100 percent (or 1:1).

SR	Seconds exposure	SR	Seconds exposure	SR	Seconds exposure	SR	Seconds exposure	SR	seconds exposure	SR	seconds exposure
.30	9	.80	16	1.25	25	1.70	37	2.15	50	2.60	65
.35	9	.85	17	1.30	26	1.75	38	2.20	51	2.65	67
.40	10	.90	18	1.35	28	1.80	39	2.25	53	2.70	69
.45	11	.95	19	1.40	29	1.85	41	2.30	55	2.75	71
.50	11	1.00	20	1.45	30	1.90	42	2.35	56	2.80	72
.55	12	1.05	21	1.50	31	1.95	44	2.40	58	2.85	74
.60	13	1.10	22	1.55	33	2.00	45	2.45	60	2.90	76
.65	14	1.15	23	1.60	34	2.05	47	2.50	61	2.95	78
.70	15	1.20	24	1.65	35	2.10	48	2.55	63	3.00	80
.75	16										

5-12. Photosensitive Materials Used in Process Camera Section

The sensitized materials consist, essentially, of two components—the base or support material, and the light-sensitive emulsion.

a. Base.

(1) *Qualities.* Material used as a base or support for the photographic emulsion must possess three qualities. First, it must be photographically inert; i.e., its chemical components do not affect the latent image or the developed image. Second, it must remain unaffected by the solutions used in processing. Third, it must have dimensional stability. Many materials meet these qualifications, but the most commonly used are plastic sheets, glass, and paper. Glass is too heavy, bulky, and fragile for most military printing units. It is used princi-

pally for the preparation of diapositives for photomapping units, but normally is not used for lithographic work. Paper is not sufficiently stable for process work. When the aim is the production of lithographic plates, the plastic bases generally are used by Army units to make copy negatives. These flexible base materials generally are referred to as films or film bases.

(2) *Common substances used as film bases.*

(*a*) Cellulose acetates are still widely used as supports for photographic emulsions because they are transparent, strong, lightweight, and flexible. These bases, however, are cast from solvent solutions, and a small amount of this solvent remains in the base. The gradual escape of the solvent during aging is a source of shrinkage. This type of base is not recommended where size stability is important.

(*b*) Photographic emulsions can be coated on a polystyrene plastic base. This base material offers unusual advantages where size stability is of critical importance. Polystyrene absorbs very little moisture, which means this film has a humidity coefficient only one-third that of an acetate base film. Its thermal coefficient is approximately the same as acetate, and temperature control is relatively more important than humidity control when using polystyrene base film. This base contains no solvent or plasticizer, thus eliminating continual shrinkage resulting from loss of solvents by evaporation.

(*c*) Polyester base photographic films have excellent size stability properties, and are only slightly affected by changes in relative humidity and temperature. Since polyester base contains neither solvents nor plasticizers, aging changes in the base itself will be negligible. Many commercial polyester base films are available, all of which have similar properties.

b. Emulsion.

(1) Photographic emulsions are not true emulsions, but suspensions of minute, light-sensitive silver halide crystals dispersed in the protective colloid medium of gelatin. In spite of this technical distinction, they are and will be referred to as emulsions. All photographic emulsions are sensitive to blue, violet, and the invisible ultraviolet light. For many applications, this sensitivity is not enough. The photographic emulsions used in photomechanical reproductions must, on some occasions, be capable of recording densities of the broader range of colors which the human eye can see; that is, the greens, yellows, oranges, and reds. When these types of emulsions are manufactured, dyes are added which make them sensitive to these other colors.

(2) There are several general types or classes of emulsions which are classified by their color sensitivity. A topographic unit's process camera section uses three types—Color Blind (blue sensitive) monochromatic; the Orthochromatic (sensitive to all colors except red); and, occasionally, the Panchromatic (sensitive to all colors).

(*a*) *Color blind.* Blue sensitive photographic emulsions record blue, violet, and ultraviolet as white. For instance, a blue line on a sheet of white paper has the same photographic qualities as the paper; that is, they both would affect the light sensitive emulsion in the same manner. Any colored images on the paper, other than blue or violet, would be clear areas on the processed negative.

(*b*) *Orthochromatic.* Orthochromatic emulsions are sensitive to all colors other than red. Because they are not sensitive to red, they can be handled in a darkroom illuminated by a deep red safelight.

(*c*) *Panchromatic.* Panchromatic emulsions are sensitive to all colors, including red, but are least sensitive to green. They must be handled in total darkness, in the darkroom. After developing for one-half the recommended time, a dark green safelight may be turned on for a short period to inspect the image.

(3) In addition to classification by color sensitivity, photographic emulsions are also classified by speed (sensitivity to light), contrast, grain, and resolving power. See TM 11–401 for information concerning these factors.

c. Selecting Films for Photomechanical Reproduction. Most photomechanical processes require negatives of extremely high contrast. This is well beyond the capability of the usual type of sensitive materials, even when developed in high contrast developers. Development contrast, or gamma, achieved in photomechanical practice ranges from 4.0 to as high as 10.0. To attain such extremely high gamma, special films are required, as well as special developers. A few steps in photoengraving and photolithography, mainly in the indirect process of color separation, require negatives and/or positives of lower contrast.

d. Manufacturer's Film Data Sheet Recommendations. The commercial film manufacturers enclose a data sheet in each film box indicating the speed and color sensitivity built into the product. For example: Dupont's data sheet for Photolith

Ortho A on a .004 inch Cronar base reads "Recommended Exposure—Line Copy—Under average shop conditions for same size reproduction, expose approximately 15 seconds at f/32 with two 35 ampere arc lamps placed 3 to 4 feet from the center of the copyboard at a 45° angle."

e. Exposure Meters.

(1) *Light meter.* Modern light meters are photoelectric cells which convert light into electrical energy. The meters are calibrated to give light value readings. These readings, when used with the film speed-aperture-exposure time calibrations, make it possible to arrive at fairly accurate film exposure times.

(2) *Principles of exposure.* The brightness of the light reflected from the subject and falling upon the light meter activates the indicator needle on the meter. This same light falling upon the film will expose the photographic emulsion.

(3) *Setting light meter.* When using the light meter, set the film speed indicator. The film speed usually will be found on the film box, or in a data sheet included in the film box. Read this carefully. Kodak high-contrast films are often rated from a neutral gray card reading.

(4) *Taking meter reading.* Place the meter about 48 inches from the center of the copyboard upon which has been placed a sheet of white paper of the maximum film size—about 24 x 30 inches. With the arc lamps on at the proper distance and angle, take a meter reading.

(5) *How to use meter reading.* Be sure the meter is set on the proper film speed. Choose the aperture at which the exposure is to be made. Use the meter to determine the exposure time. Use table 5–3 to find the multiplying factor for the scale of reproduction at which you are going to make your exposure. Multiply the time found on the meter by this factor. If you have the correct film speed index, you should have the correct exposure.

(6) *Make test exposure.*

(7) *Adjust exposure for originals with dull surfaces.*

Table 5–3. Multiplying Index for Finding Correct Exposure

To use a light meter in determining copying exposure time, remember the meter is calibrated to a camera focused at infinity; that is, light passing through the lens travels one focal length. When used for copying, the camera is not focused at infinity; therefore, to use the light meter accurately, you must use a multiplying index which compensates for bellows extension change at various scales of reproduction. With this table, use the light meter normally and multiply the time by the index number. (Formula: $(1+SR)^2$)

SR	Index	SR	Index	SR	Index	SR	Index	SR	Index	SR	Index
.05	1.10	.52	2.31	.79	3.20	1.07	4.28	1.34	5.48	1.62	6.86
.10	1.21	.53	2.34	.80	3.24	1.08	4.32	1.35	5.52	1.63	6.92
.15	1.32	.54	2.37	.81	3.28	1.09	4.37	1.36	5.57	1.64	6.97
.20	1.44	.55	2.40	.82	3.31	1.10	4.40	1.37	5.62	1.65	7.02
.25	1.56	.56	2.43	.83	3.35	1.11	4.45	1.38	5.66	1.66	7.08
.30	1.69	.57	2.46	.84	3.39	1.12	4.49	1.39	5.71	1.66⅔	7.11
.31	1.72	.58	2.50	.85	3.42	1.13	4.54	1.40	5.76	1.67	7.13
.32	1.74	.59	2.53	.86	3.46	1.14	4.58	1.41	5.81	1.68	7.18
.33	1.77	.60	2.56	.87	3.50	1.15	4.62	1.42	5.86	1.69	7.24
.33⅓	1.78	.61	2.59	.88	3.53	1.16	4.67	1.43	5.90	1.70	7.29
.34	1.80	.62	2.62	.89	3.57	1.17	4.71	1.44	5.95	1.71	7.34
.35	1.82	.63	2.66	.90	3.61	1.18	4.75	1.45	6.00	1.72	7.40
.36	1.85	.64	2.69	.91	3.64	1.19	4.80	1.46	6.05	1.73	7.45
.37	1.88	.65	2.72	.92	3.69	1.20	4.84	1.47	6.10	1.74	7.51
.38	1.90	.66	2.76	.93	3.72	1.21	4.88	1.48	6.15	1.75	7.56
.39	1.93	.66⅔	2.78	.94	3.76	1.22	4.93	1.49	6.20	1.76	7.62
.40	1.96	.67	2.79	.95	3.80	1.23	4.97	1.50	6.25	1.77	7.67
.41	1.99	.68	2.82	.96	3.84	1.24	5.02	1.51	6.30	1.78	7.73
.42	2.02	.69	2.86	.97	3.88	1.25	5.06	1.52	6.35	1.79	7.78
.43	2.05	.70	2.89	.98	3.92	1.26	5.11	1.53	6.40	1.80	7.84
.44	2.07	.71	2.92	.99	3.96	1.27	5.15	1.54	6.45	1.81	7.90
.45	2.10	.72	2.96	1.00	4.00	1.28	5.20	1.55	6.50	1.82	7.95
.46	2.13	.73	2.99	1.01	4.04	1.29	5.24	1.56	6.55	1.83	8.00
.47	2.16	.74	3.03	1.02	4.08	1.30	5.29	1.57	6.60	1.84	8.07
.48	2.19	.75	3.06	1.03	4.12	1.31	5.34	1.58	6.66	1.85	8.12
.49	2.22	.76	3.10	1.04	4.16	1.32	5.38	1.59	6.71	1.86	8.18
.50	2.25	.77	3.13	1.05	4.20	1.33	5.43	1.60	6.76	1.87	8.24
.51	2.28	.78	3.17	1.06	4.24	1.33⅓	5.44	1.61	6.81	1.88	8.29

Table 5-3. Multiplying Index for Finding Correct Exposure—Continued

SR	Index	SR	Index	SR	Index	SR	Index	SR	Index	SR	Index
1.89	8.35	2.08	9.49	2.27	10.69	2.45	11.90	2.64	13.25	2.82	14.59
1.90	8.41	2.09	9.55	2.28	10.76	2.46	11.97	2.65	13.32	2.83	14.67
1.91	8.47	2.10	9.61	2.29	10.82	2.47	12.04	2.66	13.40	2.84	14.75
1.92	8.53	2.11	9.67	2.30	10.89	2.48	12.11	2.66⅔	13.44	2.85	14.82
1.93	8.58	2.12	9.73	2.31	10.96	2.49	12.18	2.67	13.47	2.86	14.90
1.94	8.64	2.13	9.80	2.32	11.02	2.50	12.25	2.68	13.54	2.87	14.98
1.95	8.70	2.14	9.86	2.33	11.09	2.51	12.32	2.69	13.62	2.88	15.05
1.96	8.76	2.15	9.92	2.33⅓	11.11	2.52	12.39	2.70	13.69	2.89	15.13
1.97	8.82	2.16	9.99	2.34	11.16	2.53	12.46	2.71	13.76	2.90	15.21
1.98	8.88	2.17	10.05	2.35	11.22	2.54	12.53	2.72	13.84	2.91	15.29
1.99	8.94	2.18	10.11	2.36	11.29	2.55	12.60	2.73	13.91	2.92	15.37
2.00	9.00	2.19	10.18	2.37	11.36	2.56	12.67	2.74	13.99	2.93	15.44
2.01	9.06	2.20	10.24	2.38	11.42	2.57	12.74	2.75	14.06	2.94	15.52
2.02	9.12	2.21	10.30	2.39	11.49	2.58	12.82	2.76	14.14	2.95	15.60
2.03	9.18	2.22	10.37	2.40	11.56	2.59	12.89	2.77	14.21	2.96	15.68
2.04	9.24	2.23	10.43	2.41	11.63	2.60	12.96	2.78	14.29	2.97	15.76
2.05	9.30	2.24	10.50	2.42	11.70	2.61	13.03	2.79	14.36	2.98	15.84
2.06	9.36	2.25	10.56	2.43	11.76	2.62	13.10	2.80	14.44	2.99	15.92
2.07	9.42	2.26	10.63	2.44	11.83	2.63	13.18	2.81	14.52	3.00	16.00

5-13. Photographic Filters

a. Introduction. The military process cameraman normally does not use color film. Frequently, however, he must process sharp, clear, monochrome negatives from multicolored copy, and thus must have a thorough understanding of the color sensitivities of different black-and-white films, and the effects of colored filters on them. Filters are used to control contrast, to eliminate unwanted colors and to strengthen other colors on the copy.

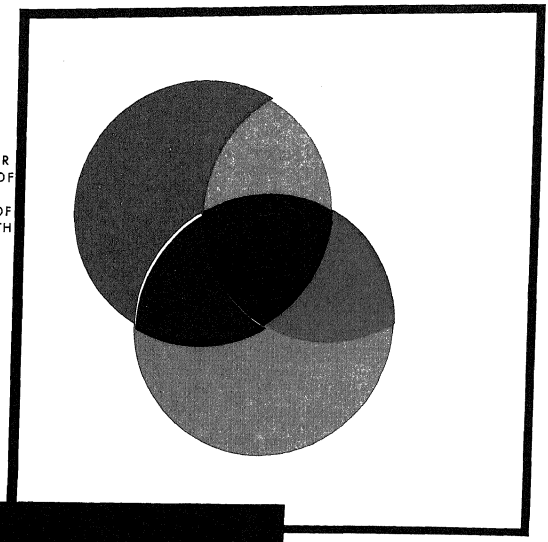
b. Color Theory. The perception of color by the human eye and brain is explained by several theories which differs slightly in their analyses, depending on whether they deal with color as pigment, or as wavelengths of light. The combination of pigments of different colors is of critical importance to the pressman who must mix inks; this aspect of color is discussed in paragraph 8-26. The photographer, however, is concerned with color as it is related to light. He bases his operations on the Young-Helmholz theory, which defines color as the visual response to wavelengths of light, and light as one form of radiant electromagnetic energy.

(1) Light waves are located between radio waves and x-rays in the electromagnetic spectrum. Light ranges in wave length from 400 to 750 millimicrons (millionths of a millimeter). The shortest wavelengths are seen by the human eye as violet, and, as the wavelengths increase, the colors change through blue, green, yellow, and orange to red, which has the longest wavelength. When lights of all these colors are combined, the result is *seen* as white light. Stated another way, white light consists of equal proportions or intensities of all colors in the visible light spectrum.

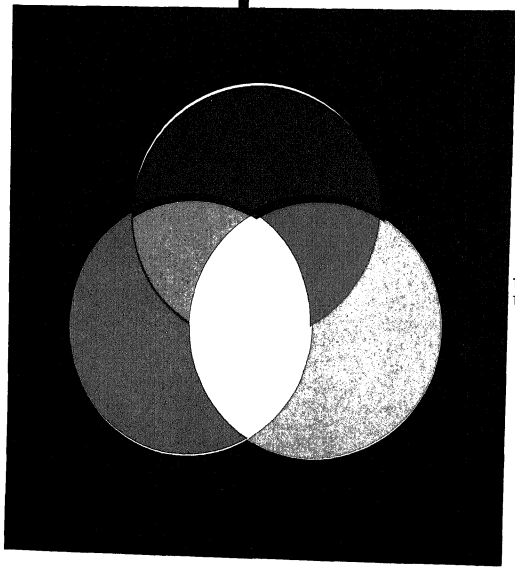
(2) Although *white light,* in fact, consists of a number of colors, psychologically, it is considered as a combination of only three primary colors; blue, green, and red. All other colors are combinations of these three primaries. Red *light* and green *light* combine to produce yellow *light*; red-blue or magenta is produced when red and blue *lights* are mixed; blue-green, or cyan, results from the combinations of blue and green *lights.* These colors, yellow, magenta, and cyan, which result from the combinations of primaries, are known as complementary colors. They are known also as secondary or subtractive-primary colors.

(3) Yellow is complementary to blue, since it is the mixture of the red and green lights which remain when blue is subtracted from white light. Similarly, magenta (red-blue) is the complement of green because it forms when green is subtracted from white light. B, figure 5-12, shows the relationship between these colors and how the *lights* corresponding to them behave. Such processes are known as *additive* since they deal with the addition or combinations of the primary-colored lights (fig. 5-12).

(4) The remaining portion of this paragraph explains the use of filters. As stated previously, the aim of the process camera section is to make



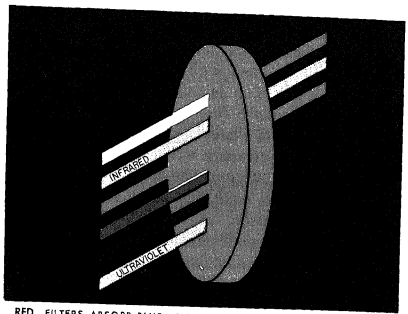
A. SUBTRACTIVE COLOR MIXTURE. THE COMBINATION OF ALL THREE COMPLEMENTARIES FORMS BLACK. THE MIXTURE OF ANY TWO IN EQUAL STRENGTH FORMS A PRIMARY COLOR.



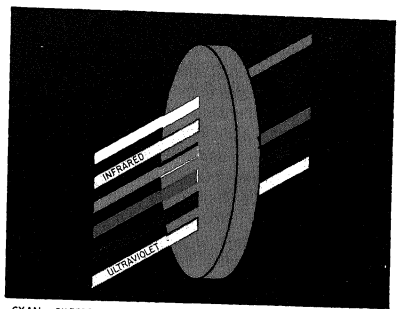
B. ADDITIVE COLOR MIXTURE. LIGHTS OF ALL THREE PRIMARY COLORS FORM WHITE LIGHT.
THE COMBINATION OF ANY TWO, FORMS A COMPLEMEN – TARY COLOR.

Figure 5–12. Additive and subtractive color mixtures.

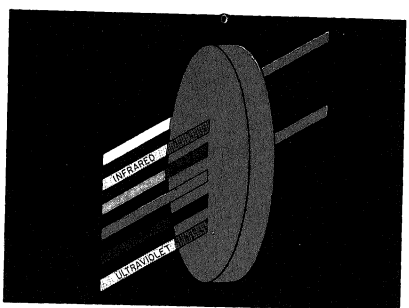
FILTER TRANSMISSION AND ABSORPTION



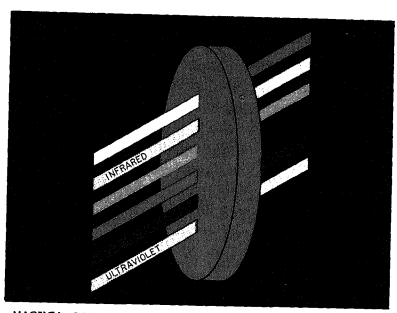
RED FILTERS ABSORB BLUE AND GREEN. RED RESULTS WHEN BLUE AND GREEN ARE SUBTRACTED FROM WHITE LIGHT.



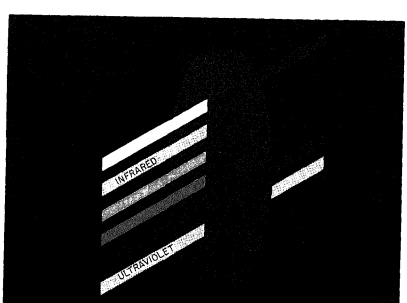
CYAN FILTERS ABSORB RED. CYAN OR BLUE-GREEN RESULTS WHEN RED IS SUBTRACTED FROM WHITE LIGHT.



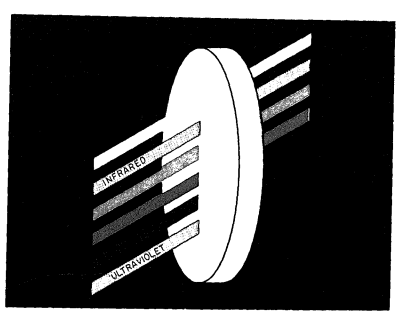
GREEN FILTERS ABSORB BLUE AND RED. GREEN RESULTS WHEN BLUE AND RED ARE SUBTRACTED FROM WHITE LIGHT.



MAGENTA FILTERS ABSORB GREEN. MAGENTA OR RED-BLUE RESULTS WHEN GREEN IS SUBTRACTED FROM WHITE LIGHT.



BLUE FILTERS ABSORB GREEN AND RED. BLUE RESULTS WHEN GREEN AND RED ARE SUBTRACTED FROM WHITE LIGHT.



YELLOW FILTERS ABSORB BLUE. YELLOW OR RED-GREEN RESULTS WHEN BLUE IS SUBTRACTED FROM WHITE LIGHT.

Figure 5-13. Action of filter is to transmit light of its own color and absorb remainder.

high contrast copy negatives in which any small part of the image will print either completely black or completely white on the lithographic plate. The small area in question will be either completely clear or very opaque on the negative. The terms "hold" and "drop" as used in this paragraph are defined as follows: A color in the copy material is "held" when it affects the negative in approximately the same manner as a black feature, that is, it leaves a clear area in the negative and will appear as a dark feature when a positive print is made from the negative. A color is "dropped" when it affects the negative in the same manner as a white feature (such as the white background), that is, it forms a dense area on the negative and will appear as a white area when a positive print is made from the negative.

c. Types of Filters Used (Written Numbers). Multicolored originals can be separated by using *primary color* filters such as No. 25(A), red, No. 58(B) green, and No. 47(C5) blue. Occasionally a filter from the *secondary color set,* No. 8(K2) yellow, or No. 15(G) orange is needed. Filters are supplied in two forms: as lacquered gelatin film, or as gelatin film cemented between pieces of optical glass. Lacquered gelatin filters are in common use because they are cheap and easily replaced when damaged, but they are also fragile, ruined easily by fingerprints, moisture, heat, and dirt and cannot be cleaned very effectively. Solid dyed optical glass filters are also made, but would be expensive in the sizes required.

d. Storing and Cleaning of Filters. Store filters in protective covers in a cool, dry place. Clean and handle glass filters the same as lenses. Lacquered and plain gelatin sheets may be cleaned by dusting lightly with a clean camel's-hair brush. Lacquered gelatin may be cleaned with cotton or lens tissue and a drop of film cleaner. Throw away faded filters. Handle filters by the edges to avoid smudging.

e. Placement of Filters. Ideally the light source is covered with a large filter and all other extraneous light is eliminated from the camera room. In the actual operation of an Army process camera section, however, this is not feasible because the source of light is the large, high-temperature arc lamps. Normally a small filter is mounted in a holder and inserted between the lens elements, a technique which prevents optical distortion. If filters are placed ahead of or behind the lens, the focal length of the lens may be changed.

f. Filter Factor (Additional Exposure Required).

(1) Filters "stop" some of the colors which, in combination, make up white light, but they "pass" light of their own color. Since the emulsions are sensitive to specific colors, the action of any filter must be determined for each type of film. The film data sheets which are included in each box of film list a factor for each type of filter which might be used with the film. This is a multiplying factor which is applied to a normal exposure to compensate for the loss in light strength resulting from the use of the filter. *For example:* If the normal exposure without a certain filter is 20 seconds at f/32 and the filter factor is 8, then normal exposure *with* that filter would be 8 times 20, or 160 seconds, at f/32. Correct exposures often can only be determined by trial and error tests. Initially at least, base your exposures on the filter factors recommended by the manufacturer of the film you are using.

(2) Listed below are common filter factors for two types of commercial orthochromatic films —Kodalith type 2 and Reprolith type B:

Filter	*Filter factor*
Yellow No. 8 (K–2)	2
Green No. 58 (B)	4
Blue No. 47 (C_5)	12

(3) Listed below are common filter factors for Kodalith and Reprolith panchromatic films—typical high contrast panchromatic emulsions:

Filter	*Filter factor*
Yellow No. 8 (K–2)	2
Red No. 25 (A)	4
Green No. 58 (B)	6
Blue No. 47 (C_5)	12

g. Guidelines for Copying With Filters. Light filters absorb and transmit specific wavelengths of light. When used with white light, a filter transmits those wavelengths which correspond to its own color and it absorbs the remainder of the wavelengths. Figure 5–13 illustrates the action of a filter. A filter, however, is not 100 percent efficient, nor are the materials to be copied always printed with pure colors. Therefore, there are few, if any, hard and fast rules for copying with filters, only guidelines. A normal exposure using panchromatic film *without filters* and with normal development genrally holds all colors. A red filter usually drops a good deal of the red and brown. A green filter drops most of the green and some of the blue. The blue filter drops the blue. All three filters are used with pan film to print only the black images from a four or five color original. *In theory* the red filter drops the red and brown, blue drops blue and green drops green. One-half of the basic exposure is used with the red filter and one-

fourth with the blue and one-fourth with the green. More exposure is used with the red and brown because they are the most difficult to drop. With a basic exposure time of 15 seconds with f/32 using Kodalith or Reprolith Panchromatic film, the exposures would be set up as follows:

With red filter—7½ seconds times filter factor of 4 = 30 seconds.

With green filter—3¾ seconds times filter factor of 6 = 22½ seconds (use 23 seconds).

With blue filter—3¾ seconds times filter factor of 12 = 45 seconds.

h. Use of Light Angles To Help Hold or Drop Colors. Light or transparent colors such as blue and green can be intensified by using a more acute light angle. A change from the normal light angle of 45° to a lesser angle increases the density of the color slightly. This helps *hold* the color. The converse is also true; a greater angle than 45° helps *drop* a color. A change in exposure time is necessary when the light angle changes. When the normal light angle is 45°, a change in light angle may be compensated for by multiplying the exposure at 45° by the multiplying index for the new angle. Table 5–4 indicates the appropriate index for various light angles.

Table 5–4. Exposure Indexes for Angles of Lighting.

Angle of lighting	*Multiplying index*
10°	4
15°	2.7
20°	2
25°	1⅝
30°	1.4
35°	1.2
40°	1.1
50°	.9
55°	.86
60°	.82
65°	.78

i. Use Exposure as Aid. An increase in exposure or development, or a combination of both, may aid in dropping a color. A decrease in exposure or development, or a combination of the two, may be useful in holding a color. Strip-exposing of one sheet of film is useful to establish best exposure time for a given color and a given filter.

j. Film and Filter Combination Guide. In table 5–5, Film and Filter Combination Guide, under the first column, titled "To photograph," the first listing is "Blue as black" and the second is "Blue as white." This table indicates that when a yellow K–2 (No. 8) filter or an orange G (No. 15) filter is used with ortho-type film, a blue image photographs black. The negative in that area is as clear as any spot on the negative where a black image, such as black type, has been reproduced. If a blue filter is used with the same type of Ortho film, a blue image photographs as if it were white. The negative is as dense where the blue image falls as anywhere where a white area, such as the normal background of a map drawing, has been reproduced. The table also shows that a red image cannot be photographed as white when using ortho film. Panchromatic film must be used to do this because ortho film is insensitive to red, that is, red always appears as if it were a very dark shade of gray or black.

k. Summary of Copying Hints When Dropping or Holding Colors.

(1) To DROP a color use a filter of the same color. If possible use one that is of the same color but darker.

(2) To HOLD a color use a filter that is complementary to that color.

(3) If possible, *mask out* unwanted color, such as stains or notations written in colored pencil in the border area. Do not waste time trying to eliminate something through the use of a filter which could be eliminated simply by covering it with a piece of white paper.

(4) Overexposure helps to DROP out a color, with or without a filter.

(5) Underexposure helps to HOLD a color, with or without a filter.

(6) Decreasing the light angle helps to HOLD colors.

(7) Increasing the light angle helps to DROP colors.

5–14. Processing Exposed Film in Darkroom

a. Introduction. TM 11–401 (Dec 1953), *Elements of Signal Photography,* has a chapter devoted to "Photographic Processing" and an appendix titled "Chemical Formulas for Photographic Processing." Use this source or other technical and professional books or manuals for an explanation of the theory and fundamentals of photographic processing. This paragraph is concerned with the specific film processing procedures followed in the process camera section of an Army topographic unit when it is engaged in map reproduction work.

b. Materials Needed in Darkroom.

Table 5-5. Film and Filter Combination Guide

To photograph	On pan film—	On ortho film—	On blue sensitive—
Blue as black	Red A (25)	Yellow K-2 (8)	(Use ortho film)
	Orange G (15)	Orange G (15)	
Blue as white	Blue (44)	Blue (44)	None or blue
Blue-green as black	Red A (25)	(Use pan film)	(Use pan film)
Blue-green as white	Blue C-5 (47)	Blue C-5 (47)	(Use ortho film)
Green as black	Red A (25)	(Use pan film)	(Use pan film)
Green as white	Green B (58)	Green B (58)	(Use ortho film)
		Yellow K-2 (8)	
Orange as black	Blue C-5 (47)	Blue C-5 (47)	None
Orange as white	Red A (25)	(Use pan film)	(Use pan film)
	Orange G (15)		
Red as black	Green B (58)	Green B (58)	None
Red as white	Red A (25)	(Use pan film)	(Use pan film)
	Orange G (15)		
Violet as black	Green B (58)	Orange G (15)	(Use ortho film)
Violet as white	Blue C-5 (47)	Blue C-5 (47)	None or blue C-5 (47)
Yellow as black	Blue C-5 (47)	Blue C-5 (47)	None or blue C-5 (47)
Yellow as white	Red A (25)	Yellow K-2 (8)	(Use ortho film)
	Orange G (15)	Orange G (15)	
Yellow-green as black	Blue C-5 (47)	Blue C-5 (47)	None or blue C-5 (47)
Yellow-green as white	Green B (58)	Green B (58)	
		Yellow K-2 (8)	

(1) Three large flat trays (preferably set in a temperature controlled sink), plus a fourth tray for washing if it is available.

(2) Two gallons (approx) of developer (see app C for formulas of representative types of developers).

(3) Three or 4 gallons of fixing bath (see the same app for the formula).

(4) Cellulose sponges, clip hangers, and a line on which to hang the negatives.

(5) Darkroom timer.

(6) Safelights.

(7) Tray thermometer.

c. Precautions During Processing. Most of the chemicals used in photographic processing can affect the skin. As was noted in paragraph 5-4, some of the acids and alkalis can cause serious burns. Others, such as metol or amidol, may cause irritation if permitted to dry on the skin. This irritation can be prevented by first bathing the hands in a 3 percent solution of acetic acid to neutralize the alkali in the developer and then rinsing the hands in water. Chemical burns (reddening of the fingers around the nails) may also result if the developer or acid fixer dries on the skin. To prevent chemical burns, wash the hands with soap and water, and then massage with glycerine. This should be done at the end of each working day when using photographic processing solutions. Rubber gloves should be worn if the skin is particularly sensitive to chemical solutions. Processing solutions may also cause stains on the fingernails and hands. Stains can be removed by bathing the hands in the following solution and then rinsing in water:

Water	(1.0 liter)
Potassium permanganate	(15.0 g)
Sulphuric acid (cp)	(5.0 cc)

d. Developing.

(1) The aim of the process cameraman, usually, is to produce sharp, *high contrast* negatives from which good lithographic plates can be made. To achieve this, use a high contrast, orthochromatic or panchromatic film and develop the exposed emulsion in a high contrast developer. See appendix C for the formula for D-85, a typical high contrast developer. Numerous commercial high contrast developers are also available. Mix, or obtain from the chemical mix section, enough developer to fill the tray to a depth of at least ½ inch.

(2) When doing map reproduction work you normally are working with a very large sheet of film, which must be handled in the following manner. Place it in the developer tray, emulsion side down, and quickly run your hands over the back of the sheet to insure that all portions of the emulsion surface are wetted evenly. During the required period of development occasionally lift the film out of the developer and place it back into the solution in order to be sure all portions of the

emulsion are developed evenly. *Handle the sheet of film by the corner and edges only!* Do not touch the emulsion during processing.

(3) At the end of the predetermined development time remove the sheet of film from the developer, allow it to drain for 1 or 2 seconds, and immerse it in the shortstop in the middle tray. Agitate the sheet of film in the bath for about 5 seconds. At this point examine, under the approved safelight, the image which has developed and decide whether to return the negative to the developer tray for any additional developing time.

e. Fixing. When the negative has developed to the desired point, transfer the sheet of film to the fixing bath tray and agitate it in the same manner as was done in the developer. The following is one rule of thumb for determining how long to leave the negative in the fixing bath. Observe the length of time required to clear the background of the film and leave it in the fixer twice as long as the period required to clear it.

f. Washing. Transfer the sheet of film to a wash tray and leave it in the tray, emulsion side up, for ½ hour with a continuous stream of water running into the tray. When running water is not available, or is in short supply, film should be processed through at least 12 changes of water.

g. Drying. Use spring clips and hang the negative up to dry. Remove excess water with two clean cellulose sponges. It is important to remove the excess water carefully so that there will be no water marks on the negative when it is dry.

h. Time and Temperature Factors.

(1) The correct developing time is determined by the type of film, the type of developer, and the temperature of the developer. By consulting a time-temperature chart for the type of developer being used, the correct developing time may be determined. First, obtain the temperature of the developer solution with a tray thermometer. Apply this reading to the temperature index line

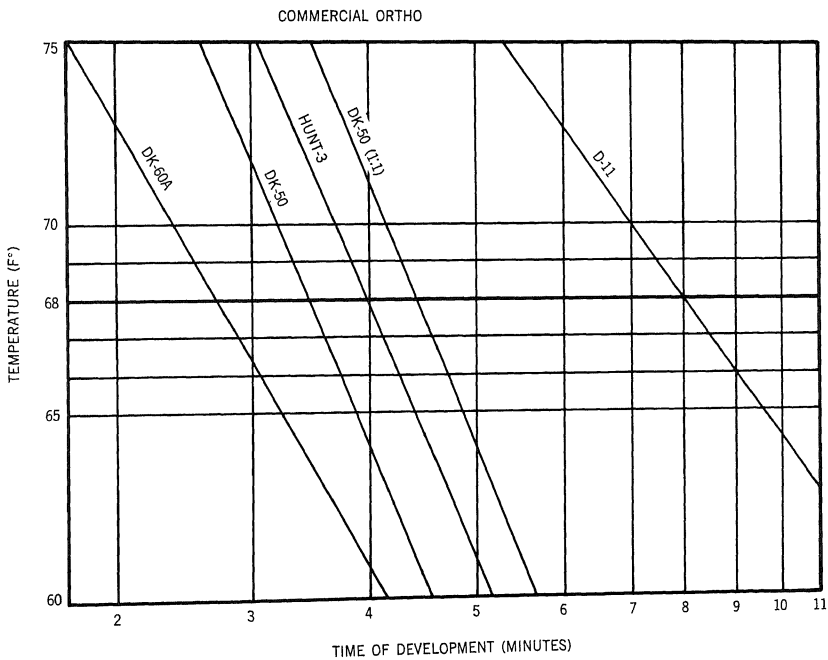


Figure 5-14. Time-temperature chart.

of the chart, read to the right to the interesection of the appropriate developer line, and find the correct developing time. See figure 5-14 for an example of a time-temperature chart for Commercial Ortho film.

(2) It is important to learn how to develop film "by the clock" so as to produce negatives that are consistent in quality and correctly exposed. The inexperienced operator can seldom differentiate between exposure and development failures, but by "using the clock" he can be sure the development is correct; therefore, only his exposure must be corrected.

i. Safelights.

(1) Safelights are used to illuminate the darkroom. They furnish a light that is safe for the photosensitive materials being processed. Since the photographic materials cover a wide range of sensitivity and speed, a series of safelights is supplied. When working with colorblind emulsions, sensitive to violet and blue light only, the green-yellow (series OA) or light orange (series O) filters can be used over the safelight openings. For orthochromatic emulsions, a deep orange (series 1), red (series 1A), or the darker red (series 2) filters must be used on the safelight frames. Ruby red incandescent *bulbs* may be used as an expedient but they often transmit light to which orthochromatic emulsions are sensitive.

(2) Panchromatic emulsions are sensitive to all colors and should be processed in total darkness. Occasional observation under a dim green light (series 3) may be made without seriously affecting the emulsion. Film manufacturers supply a data sheet with each package of film. Film speed and safelight recommendations are always included.

(3) Safelights are only comparatively safe. Light leaks, the use of bulbs with too much wattage, and bleaching of the lamp filters may render the lights unsafe. Illumination should be checked periodically by putting half-covered sheets of film in the working areas for twice the normal handling and developing period. If fog appears on the exposed area of the developed negative, the safelight is defective.

Section IV. LINE COPYING

5-15. Introduction

Line copying is the simplest and most common type of work done by the process camera section of a reproduction unit. Map manuscripts, whether monochrome or color-separated, book texts, pen-and-ink drawings, and forms are typical of the original line copy from which negatives are made to be used in preparing the lithographic press plates.

5-16. Types of Film Normally Used

a. High-contrast emulsions must be used in order to produce the type of negatives required for line copying operations. High contrast *orthochromatic* films usually are chosen for line and halftone copying, but high contrast *panchromatic* films are used when a red filter is needed. These films have an antihalation (reflection preventing) backing, a thin, tough emulsion, and are sold with a variety of bases. Films with paper, acetate, vinyl, polyester, and polystyrene bases are available in thin, regular, and thick bases, 0.0035, 0.005 or 0.010 inch thick. They characteristically can be developed, fixed, and dried quickly and they resolve very fine lines clearly.

b. When close registration is required, as with multicolor map work, films with dimensionally stable bases are used. Films produced on polystyrene and polyester bases have good handling qualities, good storage qualities, and high dimensional stability. The characteristics of high contrast films are so similar and standard that films with the same speed and similar bases can be used interchangeably. Technically the speed, contrast, and resolving power vary slightly but for most purposes the amount is negligible.

c. To keep the highest possible dimensional control of film, treat each set of film in a set in exactly the same way from the moment the box is opened. To keep the moisture content of the film constant, before exposure hang the film in the dark for an hour. Gentle air circulation is beneficial. Recondition the film the same way after processing and drying. If the temperature and relative humidity are constant, very good control is possible. Low humidity will cause static electricity in film and dust adheres to it; high humidity will, in a period of weeks, cause moisture defects such as mold.

5-17. Development

a. The exposed high-contrast film mentioned

above must be developed in a high-contrast developer to obtain the best possible line negative. See appendix C for the formula for D-85, a typical high-contrast developer. Many commercial high-contrast developers are also available.

b. Development time varies under normal exposure and work conditions from 1½ to 4½ minutes. Normal development would be about 2 minutes with some developers and 2¼ to 2½ for others. Both line negatives and halftones may be developed by inspection or by time and temperature.

c. The development time is adapted to development technique. The kind and amount of agitation often is the determining factor. Some photographers use a still developing or an intermittent agitation technique; some agitate continuously, some for only a portion of the development. Many good technicians claim that still development is best for fine lines; some agitate only until the image appears. The manufacturer's recommendations for the various films provide a reliable guide.

5-18. Common Problems in Line Copying

The cameraman can sometimes solve photographic problems resulting from poor copy by employing certain techniques, a few of which are listed below:

a. Tracings, or drawings on thin paper, should be backed up with white paper.

b. Copy with printing on the reverse side should be backed up with black paper.

c. Typed sheets should be backed up with carbon.

d. Fine ground glass or grained acetate used over pencil, charcoal, or chalk drawings elminates glare, but the vernier settings must be adjusted to compensate for the thickness of the ground glass or acetate.

e. Extremely rough prints, or copy on rough paper, may be smoothed out by soaking in glycerine, then flattening on the back side of the copyboard glass with a squeegee.

f. Originals with damaged detail may be reproduced by enlarging them, touching up the broken and damaged image, then rephotographing the repaired copy to the desired size.

5-19. Typical Line Copying Operation

Assume that you are the copying camera operator working in a mobile van. You must make a 1 : 1 copy of a 20- x 26-inch monochrome (black) map sheet. What steps do you go through?

a. Obtain the proper type of film. (Usually this will be a stable-base, high-contrast, ortho-type film when monochrome line copying work is to be done.)

b. Obtain from the chemical mix section, or mix for yourself, approximately 2 gallons of high-contrast developer and 3 or 4 gallons of fixer (hypo).

c. Fill the temperature controlled sink and arrange the developer, shortstop, and fixer trays in the sink in convenient sequence. Turn on the temperature controlling unit and wait for the developer and fixer to come to 68°F. (20°C.) before processing any film. (In some mobile vans a temperature controlled unit with deep, narrow tanks is used instead of the large flat trays. The sheets of film are developed in frame hangars.)

d. Be sure a timer is installed in the darkroom and the proper safelights are turned on (use the safelight recommended by the film manufacturer).

e. Swing the focusing glass down to its operating position.

f. Mount the lens in the lensboard with the lens cap(s) removed and the shutter and diaphragm open.

g. Prepare the copy for mounting. (Check the copy for cleanliness. Recheck the work order for copying instructions.)

h. Check, on the ratio chart for the lens being used, the recommended settings for the copyboard and lensboard for a 1 : 1 copy.

i. Use the drive mechanism controls to position the lensboard and copyboard at the recommended settings.

j. Turn on the vacuum turbocompressor and mount the copy on the copyboard. (Center the copy on the copyboard and eliminate all wrinkles or bumps on the copy.)

k. Be sure the arc lamp arm brackets are in their proper positions. In the mobile van this means at an angle of 36° to the centerline or axis of the camera (or 54° to the copyboard). Turn on the arc lamps.

l. Center the image on the focusing glass and, if scale is critical, use a beam compass to measure the image of the copy as it appears on the focusing glass. Make final adjustments for scale and focus if they are required.

m. Raise the focusing glass.

n. Close the shutter, set the lens diaphragm at the desired opening, and turn off the arc lamps.

o. Turn off all lights in the darkroom except the allowed safelights.

p. Open the box of film and remove a sheet of film. CLOSE THE BOX OF FILM!

q. Place the sheet of film on the vacuum back with the emulsion side toward the lens. Turn on the vacuum turbocompressor.

r. Lock the vacuum back in position.

s. Turn on the arc lamp.

t. Open the shutter and expose the film for the planned length of exposure.

u. Close the shutter, turn off the arc lamps and open the vacuum back.

v. Hold the film with one hand, turn off the vacuum, and remove the film from the vacuum back.

w. Start the timer and place the sheet of exposed film in the developer. Agitate it occasionally during development, in accordance with the manufacturer's recommendations.

x. At the end of the proper development time, remove the sheet of film from the developer and immerse it in the shortstop.

y. Transfer the sheet of film to the fixing bath tray and agitate the film in the same manner as was done in the developer.

z. Wash the negative thoroughly in running water for 30 minutes.

aa. Hang the negative up to dry.

Section V. HALFTONE COPYING

5–20. Introduction

a. Making halftone copy negatives is the second most common type of copying work in the process camera section. As was noted in paragraph 5–3, to reproduce a piece of continuous tone copy, such as an aerial photograph, on an offset lithographic press the range of varying shades of gray in the original must be reduced to a series of minute dot structures—either white dots on a black background or black dots on a white background. This is achieved by photographing the copy through a screen placed in front of the unexposed film during exposure. This screen can be either a glass screen containing a checkerboard pattern of opaque lines and clear squares, or it may be a flexible, magenta colored, plastic sheet composed of variable density or "vignetted" dots and clear areas. No matter which type of screen is used the following brief explanation is valid. The two types of screen techniques are explained in greater detailed in paragraphs 5–23 and 5–24.

b. The white or very light-toned portions of the original copy reflect a large amount of light which passes through the lens and through the screen to the light-sensitive emulsions. When the film is developed, the image in this portion of the negative is made up of relatively large opaque dots, which merge into one another, and relatively small clear areas. When reproduced as a positive print, this area will appear light in tone. The black or very dark-toned areas reflect little or no light. The portions of the light sensitive film corresponding to these dark areas on the copy remain unexposed regardless of the fact that the halftone screen is in front of it. When reproduced as a positive print, this area will be a solid black. In order to break up this solid black area so that it will have some texture and print better on the offset lithographic press, the negative is usually given an overall flash exposure through the screen. This means that an additional direct flash exposure of the light-sensitive emulsion is made through the center of each of the minute clear areas. The effect of this second exposure is negligible in the heavily exposed portions of the image corresponding to the light areas in the original copy. In these areas the light-sensitive emulsion already has a latent pattern of dots from the first exposure, but in the dark areas, which otherwise would have been completely clear, a pattern of fine opaque dots develops during processing.

5–21. Types of Film Normally Used

Any standard photomechanical (high-contrast) film can be used to make halftone negatives. Where scale retention is important, however, such as when copying an aerial photomosaic, only stable-base films in either orthochromatic or panchromatic sensitivity give good results.

5—22. Types of Developers

Standard high-contrast developers may be used within their allowable temperature range for 1½ to 3½ minutes. For any other temperature within the usable range of 65° to 70° F. consult a time-temperature chart to determine the correct development time.

5—23. Producing Halftone Negatives With Contact Magenta Screen

a. Theory of Magenta Contact Screen.

(1) The magenta contact screen is composed of evenly spaced vignetted dots of varying density. Each of these dots is most dense in the center and least dense at its edges. The screen is made on continuous tone film and developed in a magenta dye coupler which replaces the silver in the film emulsion. The magenta dyed dots are more transparent to magenta light than to any other. This principle is used as the basis for contrast control.

(2) White light passes readily through the center of the clear areas. The size of the dot is governed by the amount of light reflected from the copy and through the screen. A highlight (white) area on the copy reflects a large amount of light through the screen, forming large opaque dots on the negative. A gray area on the copy reflects a lesser amount of light, forming smaller dots on the negative. A dark area on the copy reflects little or no light through the screen. No dots form in this area.

b. Types of Screens. Magenta contact screens can be obtained in various sizes and in several "rulings" (i.e., the number of lines of dots per in.). The more lines, the finer the detail that can be reproduced. The process camera section of a mobile Army topographic mapping unit uses magenta contact screens with two rulings—150 and 300 lines per inch. The finer screen is used for the printing of aerial photomosaics when fine details must be reproduced. Printing plants which use the rougher grades of paper, such as newsprint, use screens as coarse as 50 lines per inch.

c. Use of Filters and Flash Exposures to Control Contrast.

(1) *Filters.*

(*a*) Because the dots are more transparent to magenta or rose colored light than to any other colored light and more opaque to yellow light, overall image contrast can be controlled by the use of a rose (or magenta) filter or a yellow filter respectively.

(*b*) Overall image contrast is *high* (the halftone dot structure of the light areas is altered so that the area approaches pure white in the positive print) when the light from the original copy is passed through a rose or magenta filter (Wratten No. 30) before it passes through the screen and strikes the light-sensitive emulsion.

(*c*) Overall image contrast is *low* (the light areas in the positive print become grayer and they contrast less with the shadow areas) when the light is passed through a yellow filter (Wratten No. 4) before it passes through the screen and strikes the emulsion.

(2) *Flash exposures.* In addition to the main exposure, a flash exposure with a yellow light flashing lamp aimed directly into the camera lens is required for most copying operations. The main exposure, made with the arc lamps illuminating the original copy material, usually does not provide enough exposure in the shadow (dark) areas to produce a satisfactory "shadow" dot. This is the pattern of fine, opaque dots in the otherwise clear areas of the negative which is needed if the shadow areas are to print properly on the offset press.

d. Mounting Screen.

(1) Before mounting the contact screen, check the vacuum back of the camera for cleanliness. Remove any bits of tape, and if the back is still dirty, clean it with a small amount of benzine on a clean, lintless rag. Allow the back to dry before proceeding. When the back is dry and clean, turn on the vacuum pump and mount a sheet of film.

(2) The magenta contact screen, as the name implies, is placed in direct contact, emulsion-to-emulsion, with the copy negative, and is held flat against the film by suction. It can only be used in a camera with a vacuum-type film holder. When the screen is removed from its protective container it should be handled by the corners only. Touch the screen as little as possible! Each time the screen must be cleaned some of the magenta dye is removed. This alters its light filtering factor. Also, the surface becomes so scratched and faded that it is no longer usable. Hold a sheet of tissue paper over the contact screen, and by light rubbing smooth any ripples or creases out of the screen to insure good contact with the film. If a number of exposures are to be made with the same screen, the handling may be reduced by fastening the top of the screen to the vacuum back with a thin strip of *masking tape* (*no transparent tape*). The succeeding sheets of film may then be inserted under

the screen and any wrinkles in the screen removed by light rubbing using a cover paper as described above.

(3) Before returning the screen to its container check it for cleanliness. If there are smudges or fingerprints on the screen they should be removed with a clean lint free cloth saturated with a mild cleaning solution such as the one given below.

Alcohol	4 ounces
Wetting agent	1 capful
Water	1 gallon

Cleaning with solutions removes some of the magenta dye, so handle the screen with care and keep it clean.

e. Exposure—Controlled Flash Method.

(1) Place a sheet of unexposed high-contrast film on the camera vacuum back.

(2) Cover a 1-inch strip along one edge of the sheet of film with black paper.

(3) Make a main exposure through the magenta contact screen without filters. Under average conditions with two 50-ampere arc lamps approximately 4 feet from the copy, this exposure may be about 30 seconds at f/16. See paragraph 5–11 for a review of the many variable factors which enter into exposure determination.

(4) Cover the main exposure area of the sheet of film with black paper and uncover the 1-inch strip.

(5) Set up the yellow-light flashing lamp so that it is in position to shine directly into the lens. (If a flashing lamp is not available the same effect can be achieved by exposing the negative to a large white sheet of paper mounted on the copyboard and illuminated by the arc lamps. A yellow filter must be mounted between the lens elements to achieve the same spectral effect as the yellow-light flashing lamp.)

(6) Expose the strip of unexposed film to the yellow-light lamp through the magenta contact screen, using exposure times such as 5, 10, 15, 20, 25, 30, 35, and 40 seconds for different portions of the strip. This is accomplished by covering all but 1 inch of the unexposed strip with black paper. Expose this area for 5 seconds. Open the camera back and move the covering paper so that approximately 2 inches of the strip are uncovered. Expose this area to the flashing lamp for 5 more seconds. Continue this process until the planned range of exposures has been made.

(7) Develop the film for 2¼ minutes with full agitation in high contrast developer at 68° F.

(8) Inspect the negative and determine which of the flash exposures produces a normal-size (10%) shadow dot. This is known as the "basic flash exposure." This procedure need be followed only once in order to determine the basic flash for the conditions under which you normally operate. The exposure will remain the same unless the conditions change (i.e., lights, camera, film, screen, and developer). It is especially important to record and retain the lensboard and aperture settings. To obtain the same effect from the same flash exposure, the lens must be at the same aperture setting and bellows extension as it was when the basic exposure was made.

(9) The final negative can now be made. If the highlight areas in the first negative were too "open," i.e. the clear areas are too large, or if they are too "closed up," i.e. the clear areas were too small, the main exposure must be adjusted. If the highlight areas are too "open," increase the main exposure. If they are too "closed up," reduce the main exposure. Give the whole sheet of film a flash exposure equal to about ONE-HALF THE BASIC FLASH EXPOSURE. One-half is used because the basic flash exposure was determined without taking into account the main exposure. If inspection of this negative indicates that further adjustments are required, change the main exposure to control the highlight dots (this has some effect on the shadows as well) and vary the flash exposure to control the shadow dots. A little experience in judging original copy will enable you to estimate exposures quite easily.

(10) In addition to the two techniques for making flash exposures described in (1) through (9) above, there is one more way of obtaining flash exposures—using a yellow filter safelight *inside the darkroom*. Mount a safelight about 6 feet from the center of the vacuum back when it is in its open position. Leave the magenta screen in place over the negative. Use a 7½ watt frosted lamp and a Wratten series 00 filter. This provides yellow light requiring an average flashing time of 15 to 30 seconds. In determining the time to be used for negatives, make a test exposure of 10 to 80 seconds until a satisfactory flash dot is formed. The exposure time for the copy negatives will be about one-half of this test time if no highlight exposure is used in the test. One advantage of this system is that it is unnecessary for the operator to leave the darkroom during exposure. Another advantage is that no compensation has to be made for changes in lens aperture settings or bellows extension when trying to duplicate the shadow dots exposure.

f. Development. When the exposure is completed, immerse the film in a high contrast developer. Agitate the film evenly for 2¼ minutes. If the temperature of the developer is other than 68° consult a time-temperature chart for the correct developing time.

5-24. Producing Halftone Negatives With Glass Screen

a. Introduction. Glass halftone screens are no longer included in the set for the truck-mounted topographic camera section, which uses only magenta contact screens. Certain other military printing units may use glass screens, however, and they must be used for halftone work with any process camera which does not have a vacuum-type film holder. This paragraph presents a brief explanation of the principles of the glass halftone screen and techniques for its use in obtaining good halftone negatives.

b. Description. The glass halftone screen consists of two sheets of optical glass, each of which has fine, parallel lines etched on one side. The lines are filled with pigment to make them opaque and the sheets of glass are sealed with the etched surfaces together, and the parallel lines crossing each other at right angles.

c. Principles.

(1) The glass halftone screen, when properly set up to make halftone negatives, does not touch the light-sensitive emulsion as does the magenta contact screen. It has to be set a precise distance ahead of the film and exactly parallel to the sheet of film held flat on the vacuum back of the camera. Only when it is in the correct location relative to the emulsion can the ruled, opaque lines and square openings produce opaque dots of varying sizes on the processed negative.

(2) Perhaps the best way to explain the effect of several exposures at varying apertures (including the "flash exposure" at a very small aperture) is to consider the effect of the different exposures, one by one, and see how each contributes to the buildup of the latent halftone image on the light-sensitive emulsions. The four exposures and the areas in the image which they affect most directly are, the highlight exposure, the middletone exposure, the detail (shadow) exposure, and the flash exposure.

(3) The first areas to be considered are those portions of the image which correspond to highlight areas on the original copy. At the "highlight stop" the diaphragm is relatively wide open. A large amount of light reflected from the highlight areas passes through the small openings in the screen, and strikes the light-sensitive halides in the emulsion with enough strength to expose relatively large dots. The dots overlap each other leaving only small unexposed areas on the negative. In these highlight portions all subsequent exposures at smaller diaphragm openings merely reinforce the centers of the already exposed dots.

(4) The second areas to be considered are those portions of the image which correspond to middletone areas on the original copy. During the "highlight stop" exposure the diaphragm is open very wide. Compared to the reflection from the highlight areas, a lesser amount of light is reflected from these middletone areas. This smaller amount of light, after it passes through the small openings in the screen, strikes the light sensitive emulsion, but without enough strength to affect the light sensitive halides. A second exposure is made at a "middletone stop." The middletone area affects a slightly smaller dot than the area struck during the highlight exposure. The effect of this light striking the emulsion, exposed during the highlight stop, is the formation of a latent image of dots. These dots, however, have a smaller diameter than the ones formed from the light reflected from the highlight areas. All subsequent exposures, at smaller diaphragm openings, merely reinforce the centers of the already exposed dots.

(5) The third areas to be considered are those portions of the image which correspond to fairly dark gray areas or to small features and items of detail which are not yet part of the latent image on the copy negative after the highlight exposure and the middletone exposure have been made. During the highlight exposure these areas reflect a small amount of light which, after it passes through the screen, strikes the light-sensitive emulsion but without enough strength to permanently affect the light-sensitive halides. During the middletone exposure an additional amount of light strikes the emulsion, but even the two exposures combined do not affect the emulsion. A third expsoure, made at the "detail stop," affects a smaller-sized dot than the area struck during either of the first two exposures. The effect of this light striking the emulsion, which already has been slightly exposed during the first two exposures, is the formation of a latent image of dots. These dots, however, have a smaller diameter than the ones formed from the light reflected from the highlight areas and from the middletone areas. The subsequent flash exposure made with a still smaller diaphragm opening, merely reinforces the centers of the already exposed dots.

(6) The final areas to be considered are those portions of the image which correspond to the dark, shadow areas. During none of the previous exposures, even when the effects of the three exposures are combined, do these shadow areas reflect enough light to affect the emulsion. If the film is developed at this point there will be completely clear areas on the negative which will be solid black on the positive print. In order to break up these solid areas, the emulsion is exposed a fourth time to a flash of light shone directly into the lens, or a blank sheet of white paper mounted over the copy and illuminated by the arc lamps. This creates a shadow dot in the blank areas. This "flash exposure" is made with the diaphragm set at an extremely small stop. In those portions of the image which already have a latent dot pattern, this shadow dot merely reinforces the existing dots.

(7) In order to determine the best separation distance between the glass screen and the film, the size of the openings between the opaque lines, the refractive index of the cover glass, and the thickness of the film must be taken into consideration. It has been found through experience that, for a screen ruled 133 lines to the inch, the distance from the cover glass of the screen (the glass surface facing the emulsion) to the vacuum back must be about .216 of an inch.

d. Exposure System.

(1) Many exposure theories and systems for producing halftone negatives have been developed by experienced copy camera technicians. Each system has some merit and, if it is followed through, can be used to produce good negatives. In this subparagraph, however, we are limiting our presentation to one system—the three-stop and flash system.

(2) In this system, the first step in determining the exposures for making a halftone negative reproduction is to find the tonal range of the original continuous tone copy. Do this by matching the lightest and darkest tones with the tones of a 10-step gray scale. After finding the tonal range of the original, look up the exposures and apertures for that range in table 5-6.

(3) As has been stated previously, the copying of aerial photo mosaics is the chief type of halftone copying work done by the process camera section of a map reproduction unit. Since the tonal range of a mosaic must be exactly reproduced, the exposure is made for a tonal range of 1 to 10, regardless of the actual range. According to the chart shown above, the four recommended exposures for reproducing a mosaic at 1 : 1 (100%) when the copying camera is equipped with twin arc lamps and a flashing lamp are: 45 seconds at f/22, 90 seconds at f/32, 180 seconds at f/45, and 35 seconds of "flash exposure" at f/90.

Table 5-6. Exposure Guide for Making Halftone Negatives With 133-Line Glass Screen (Scale of Reproduction—100%, Type of Film—Type III Kodalith, 15-Second Basic Exposure)

Tonal range	Highlight exposure f/22	Middletone exposure f/32	Detail exposure f/45	*Flash exposure f/90
1–10	45	90	180	35
2–10	55	100	180	35
1–9	45	70	120	35
2–9	55	80	120	35
3–9	70	90	120	35
2–8	55	70	100	35
3–8	70	80	100	35

*Note. Flash exposures made with the flash lamp (60 watt bulb) are fairly uniform without respect to the tonal range of the original. If a flash sheet of white paper is used, expose 60 to 70 seconds.

(4) Because there is an appreciable change in the focal points when light passes through the screen at scales of reproduction smaller or very much larger than 100 percent, adjustments in screen separation are needed. When making halftone negatives at scales less than 50 percent, *decrease* the screen separation 1/64th of an inch (.016) between 40 and 50 percent; decrease 2–64ths of an inch (.031) between 30 and 40 percent. When shooting at scales above 220 percent, *add* 1/64th of an inch between 220 and 250 percent; add 2/64ths of an inch between 250 and 275 percent; and 3/64ths of an inch (.047) between 275 and 300 percent.

e. How to Handle, Clean, and Store Glass Screens.

(1) Avoid getting fingerprints or grease on the screen. Avoid scratching the screen with dirty or abrasive cleaning materials. Blow dust off with an air bulb or use a clean camel's hair brush. Remove spots with surgical cotton or lens tissue, and a drop of water, or a drop of alcohol. Use alcohol sparingly for it will dissolve the cement if it seeps into the joint between the two sheets of glass. Do not polish a screen with silk; this creates static electricity which attracts dust particles. Use cleaning agents with toxic fumes only in a well ventilated room away from fire. Do not place a screen under strain; if the glasses separate, air gets in between them and distorts the rays of light passing through. Do not warm a screen in cold weather. If the screen sweats, rub it with glycerin,

or keep a hot bottle wrapped in a black cloth inside the bellows.

(2) If the screen becomes coated with a greasy film or greasy smoke from the vacuum pump, clean the screen and polish it with optical rouge, water, and clean surgical cotton. Place four or five large clean photographic blotters on a smooth table and place the screen on the blotters. Pour a small pool of optical rouge about as large as a silver dollar in the center of the screen. Use a piece of damp cotton to spread the rouge evenly over the screen. Let it dry and polish it off gently with a piece of dry surgical cotton. Repeat on the other side.

(3) Store screens on edge in a cool, dry place to prevent warping. Never store a screen in the sun, near a wall, radiator, or stove. Do not drop, jar, or expose it to rapid temperature changes. Do not twist it or apply pressure to it.

5–25. Rescreening

a. Introduction. Occasionally a halftone copy negative must be made of a piece of original copy material which already has a halftone screen pattern. If the original material was made with rough screen (less than 100 lines per in.), a line copy negative usually can be made which reproduces the original dot pattern as if it were a line pattern. This type of copying requires sharp focusing of the camera, correct development, and correct exposure. If the original material was produced with a screen finer than 100 lines per inch, a line-type copy often cannot be made successfully. The dot pattern is too fine to be resolved satisfactorily when standard developers are used. If a fine grain, high contrast developer is used with a still development technique, graphic material made with a screen pattern finer than 100 lines per inch *can* be copied in this manner without losing the halftone dot structure. Many process cameramen, however, feel it is necessary to rescreen the finely screened originals and make new halftone negatives. If normal halftone procedures are followed, however, the resulting negative probably will have a moire pattern running though it. This is an evenly spaced, overall pattern which results from the conflict between two halftone screen patterns which overlap. The only real problem of rescreening, then, is how to prevent the development of the moire effect, or, if this is impossible, to keep it to a minimum.

b. Eliminating Moire Pattern. When the screened copy is mounted normally on the copyboard, it can be assumed that the dot pattern is alined at 45°. This is the alinement in which the individual dots of the pattern are least obvious to the eye of the viewer. If the lines of dots run up and down or side to side, that is, at 0° or 90°, the pattern will be most obvious. Because of this fact the rectangular glass halftone screens are manufactured so that when mounted in the camera the dot pattern is automatically oriented at 45°. The task for the cameraman is to mount the screened copy on the copyboard in such a way that the conflict between the pattern of dots on the copy and the pattern of dots on the screen is kept to a minimum. Experience has shown that a difference of about 30° in the angles of screening produces the best results possible. This can be accomplished in several ways.

(1) If a circular screen is available, and if the original was screened at a 45° angle, rotate a circular screen to an angle of 15° or 75° from a horizontal base line to obtain a negative with minimum pattern. If these angles create an unsatisfactory pattern, move the screen slightly until the least pattern is produced.

(2) Since the rectangular screen cannot be rotated to change the angle of the dot pattern, it is necessary to rotate the copy on the copyboard in such a way that the minimum moire pattern is achieved. One way of establishing a new base line is to use a 30°–60° triangle as shown in figure 5–15. Examine the copy with a magnifying glass to find the alinement of the dot pattern. If the sides of the right angle of the triangle are alined with the right angle pattern of dots on the copy, the long side of the triangle will indicate the correct direction of the new base line. Extend this new line to the edges of the copyboard and draw it in the margins. When this base line is alined with the horizontal line on the copyboard, it establishes the optimum difference of 30° between the angle of the dot pattern on the copy and that on the screen.

(3) The screen pattern can sometimes be eliminated by making a continuous tone negative and print from the screened original, and then rephotographing the print with a screen.

(4) If an airbrush is available, an enlarged print of the original can be retouched with the airbrush to merge the dots into continous-tone graduations. The retouched copy is then reduced to its original scale and rescreened.

(5) The copyboard with the screened original in place can be moved slightly out of position, resulting in an out-of-focus image. When viewed in

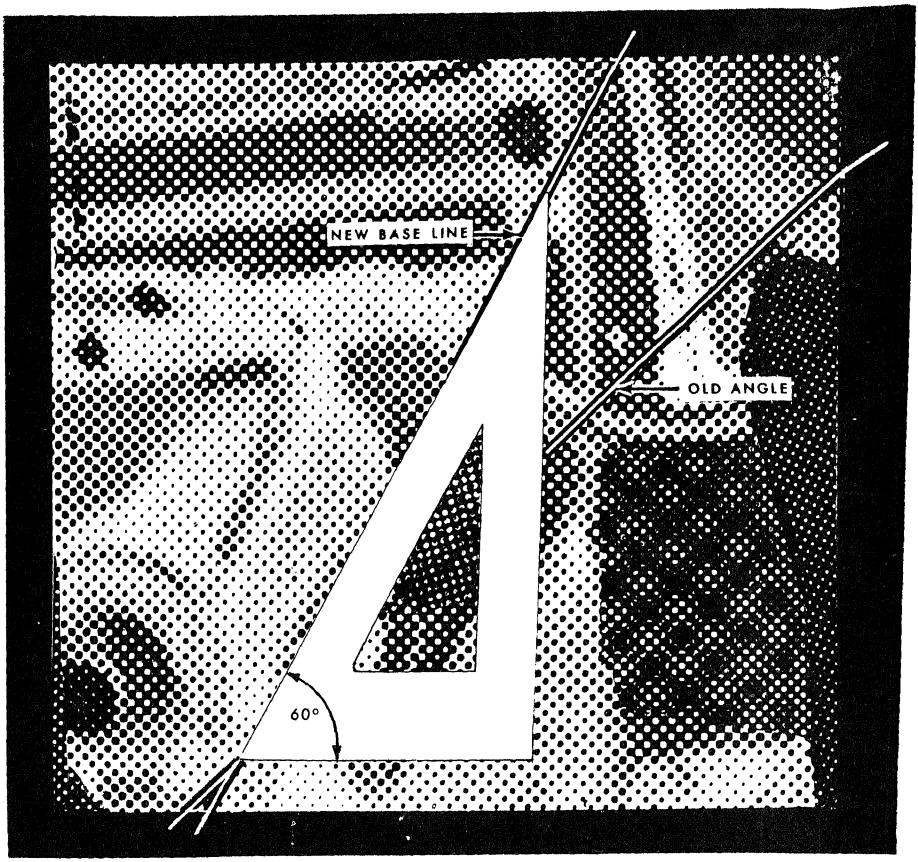


Figure 5-15. Establishing a new base line for rescreening.

the ground glass under magnification, the dot formation disappears and the copy appears as a continuous tone image. Proceed as if the original were a continuous tone image.

Section VI. CONTINUOUS-TONE COPYING

5-26. Introduction

The aim of the process cameraman when he engages in either line copying work (para 5-15 to 5-19), or halftone copying (para 5-20 to 5-25), is to produce a high contrast copy negative. This means that any small portion of a line negative or a halftone negative should consist of either a clear or opaque area. For this reason the cameraman uses high-contrast film and a high-contrast developer. However, when continuous-tone copying, such as making photo copies of aerial photomosaics, is to be done, the aim changes. Now the cameraman tries to capture in the negative the full range of

gray tones of the original. To accomplish this he uses a different type of film and different types of developers from those he uses for line negatives. These two factors (film and developer) are covered briefly in paragraphs 5–27 and 5–28.

5–27. Type of Film Normally Used

a. Commercial Orthochromatic film is the standard type of continuous-tone copying film used by Army process camera sections, but other types of emulsions may be used. A panchromatic film may be used when the original material to be copied has all colors in it, or when a red filter is to be used.

b. The basic exposure for commercial ortho films when used with the 24- x 30-inch mobile camera with its attached arc lamps set at 41 inches from the copyboard is—6 seconds at f/64 (for a 100% scale of reproduction). The manufacturer's data sheet, which normally is included in all boxes of film, should be read before exposure and processing.

5–28. Developing

There are many developer formulas which could be used when processing continuous-tone negatives. Two common formulas are DK–50 and DK–60a. The temperature, time, and dilution are tabulated in table 5–7 for these two. Other developers and techniques are discussed in TM 11–401.

Table 5–7. Time-Temperature Chart, DK–50 and DK 60a

Developer	Approximate tray temperature-time (°F.)					Strength
	75°	70°	68°	65°	60°	
DK–50	2′50″	3′20″	3′30″	4′	4′30″	Full
DK–50	4′45″	5′20″	5′40″	5′	6′50″	1–1
DK–60a	3′30″	4′30″	5′00″	6′	7′50″	Full

Section VII. CAMERA PROCESSING FOR PICTOMAPS

5–29. Pictomaps

One of the newest map products, the pictomap, departs from the three basic types of copy commonly produced by process cameramen and described in sections IV, V, and VI above. Its name is the acronym for Photographic Image Conversion by Tonal Masking Procedures. Although it is a form of photomap, the continuous-tone photo moasic from which it is made is not screened, as are standard photomaps, to produce copy which can be lithographed. Instead, the continuous tones of the photomosaic are separated, and when reproduced on a special litho-type high contrast film, achieve a granularity sufficient to permit lithographic printing in the various colors specified for the types of tone. The resulting pictomap resembles a continous-tone colored photograph, surprinted with map data, but is actually a composite color lithographic print made from a series of tonal separations accomplished by camera methods.

5–30. Development

The current procedures for the production of pictomaps are descriped in TOPOCOM TM S–1. Although continuing research and experimentation may modify the specific techniques, the basic principles remain the same and have been employed by the graphic arts industry for some years. "Bird's-eye" city maps, which look like fine engravings of an oblique view of a city, are among the more familiar applications of these principles. The same concepts were adapted and developed into the pictoline process and further refined into the pictotone process, by the U.S. Army Topographic Command (TOPOCOM), formerly the Army Map Service, to provide expedient monochrome map substitutes from vertical aerial photography. Pictolines and pictotones were the forerunners of the pictochrome, the multicolor product now referred to as the *pictomap*.

a. Pictolines. The pictoline is made by registering a continuous-tone negative *back-to-back* with a positive of nearly equal contrast made from the same photomosaic, and exposing the two, *negative down*, to a sheet of "litho-type" film with an *oblique* light source. The light rays bend around the edges of the mask images, outlining the photographic features and exposing only a line image to the film. When this line image is overprinted on a halftone of the original continuous-tone copy, the result is the pictoline map.

b. Pictotones. The same methods, with a few modifications, were used to produce pictotones, continuous-tone images which can be lithographed. In the pictotone process, the light source is vertical, instead of oblique, and the exposure time is greater than for pictolines. The light rays penetrate the mask, and when they strike the lithotype film, a fine random pattern similar to screening results. Additional masking makes it

possible to reproduce most of the continuous tones in the original copy as line tones, reproducible on a lithographic press.

c. Pictochrome. The pictochrome is a refinement of the methods used to produce the pictotone, with the added feature of printing the separated tones of the original photography in colors appropriate to the terrain. When the colored photo imagery is overprinted with map symbolization where necessary, the resulting product is known as a *pictomap*. The accuracy of a pictomap product is that of the original photo mosaic. If a standard photomosaic is used for the base, the resulting pictomap retains its inherent distortions but serves as a valuable supplement to a topographic map. If the base is an orthophotomosaic, however, scale and other distortions have been removed, and the resulting *orthopictomap* approaches the accuracy of a topographic map.

5–31. Making a Pictomap

a. Equipment and Darkroom. Because of the precision necessary in the camera processing of the pictomap components, certain equipment not normally essential for copy camera work is required for pictomap processing. Similarly, darkroom conditions must be as controllable as possible to insure good results.

(1) *Power source.* A voltage regulator and constant power transformer are necessary for a smooth and steady source of power. It is impossible to control the exposures to the extent required for pictomaps if the power supply is erratic. The transformer makes it possible to control the amount of light without changing the wattage of the bulb.

(2) *Darkroom.* If at all possible, the walls of the darkroom should be painted black. If this is impracticable, the working area should be enclosed with black curtains during exposure and development.

(3) *Light source.* The ideal light source is a plain white bulb, 150 watts, of the projector type. A #212 projection bulb gives good results. There should be no stamps or lettering on the end of the bulb, because such markings will cause blind spots during exposure. Except for the initial camera negative, made from the original photomosaic, arc lights are not used in the pictomap process.

(4) *Developing trays.* It is important that the developing trays be large enough to permit complete control of the flow of solution over the film. The tray should be at least 8 inches larger than the film in both length and width. If the tray is too small, the solution washes back over the film when it is agitated, increasing its effect, and making proper timing impossible.

(5) *Climate control.* Because of the extremely precise registration necessary in some of the steps of pictomap processing, it is important that both the temperature and humidity of the darkroom area be controlled. In addition to air conditioning, a temperature-controlled sink is required, and the temperatures of the chemical solutions used in developing should be kept as close as possible to those recommended by the manufacturer.

(6) *Freshness of materials.* Only fresh film and chemical solutions should be used in pictomap processing. Old or exhausted developer and fixer can seriously impair results. All the film needed for a particular pictomap should be stored under the same conditions of temperature and humidity to eliminate any registration problems arising from differential shrinkage and expansion.

(7) *Types of film and developer.* Good results have been obtained by the use of the following films and developers:

(*a*) For the continuous-tone stages of the process (camera negative, contact positive, duplicate negative, and 80% positive mask), Kodak Commercial (not to be confused with commercial ortho) film, and Selectol Soft developer.

(*b*) For the remaining stages, Kodalith Ortho type 3 film, and Hunt's Premium Graph-o-lith developer.

(*c*) To avoid wasted materials and unsatisfactory results, no substitutions for the above films and developers should be made unless recommended by TOPOCOM. As equivalent products are developed and tested, their use will be authorized in applicable specifications.

b. Materials. The photomapping section prepares the basic photomosaic or orthophotomosaic to be used for the pictomap. It also prepares color-separated copy of any topographic detail to be overprinted on the pictomap. Depending on the nature of the terrain, the extent of cultural development, and the scale of the pictomap, these may include any or all of the following:

(1) Contour negative and type overlay (to print black).

(2) Grid negative and type overlay (to print black).

(3) Drainage negative (to print blue).

(4) Open water negative (to print blue).

(5) Roads and buildings negative (to print red).

(6) Names and marginal data (to print black).

(7) Elevation type overlay (to print red).

c. Block-Out Masks. Because almost all of the pictomap is covered with various colors, white, or the absence of all tones, can represent or emphasize certain types of features. This is especially true of built-up areas, large buildings, street patterns, and similar features. Block-out masks are made at the camera stage for all such areas and features, for some type, such as elevation values, and for certain other spot and line features which are shown in symbol colors and therefore are more effective if they don't overprint the colors of the pictomap. These masks are combined into an overall block-out mask, to be used in processing each of the three basic pictotone plates.

d. Pictochrome Colors. The continuous tones of the average photomosaic fall generally into three basic categories: light, middle, and shadow. The light tones on the photo image are usually of uncovered earth areas, and are separated to print in a buff color, called *landtone.* White buildings, concrete areas, and similar features that should remain white are blocked out of this plate. Middle tones on most photo images represent vegetation, and are printed in a green color called *vegetone.* Again, those nonvegetation features which fall into this tonal range but which should not print in green are blocked out. The darkest tones make up the third tonal plate, called the *shadowtone,* which is printed in a black-green, a black, or sometimes a dark gray tone. In those few areas of the world where one of the basic tones is inappropriate, such as *vegetone* in a desert or icefield area, or *landtone* in a densely canopied jungle, the colors for the tones are adjusted to conform with the nature of the terrain. Project instructions specify any departures from normal procedures that may be necessary.

e. Procedure.

(1) A continuous-tone camera negative is made from the photomosaic (first generation negative) and a contact positive is made from this (first generation positive).

(2) A contact duplicate negative (second generation negative) is then made from the contact positive. The use of second generation negatives and positives intensifies the pattern of the photo image and provides more granularity than can be obtained from the original negative and contact positive.

(3) An 80% positive mask (second generation positive) is made from the contact duplicate negative, by regulating the exposure and development times. The density of this mask is such that it transmits only 20 percent of the light to which it is exposed.

(4) The key to the pictotone master positive is the preparation of the pictotone master positive. This is made by "sandwiching" the second generation negative between the 80% positive mask on the top, and high contrast litho-type film on the bottom, and then exposing the "sandwich" to a vertical light source (fig. 5–16). The negative and positive must be back-to-back and perfectly registered. So critical is the need for accurate registration of this copy that tiny pinpoints caused by dust particles are sometimes used for visual registration. The negative emulsion must be in contact with the litho-type film emulsion. The resulting pictotone master positive is used to prepare the three basic pictotone colors. It has a fine dot pattern, and has a flat, yellow look, appearing to be overexposed and underdeveloped. Maximum development time is about 1½ minutes. Extremes of tone that are solid black or white should be avoided. In the most effective master positive, all areas are "open", that is, they all contain some pattern.

(5) *Vegetone printer.* The pictotone negative is a contact, emulsion-to-emulsion negative of the master positive on which all tones, from the lightest to the darkest, are held. When combined with the composite positive block-out mask, this negative is used to make the *vegetone* plate.

(6) *Landtone printer.* A reverse positive,

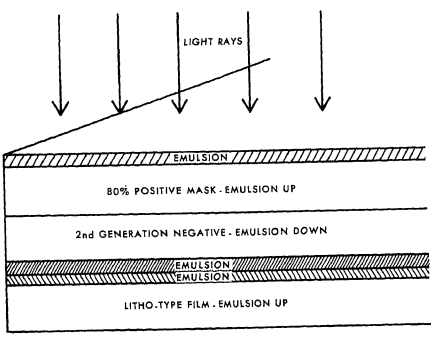


Figure 5–16. Preparation of pictotone master positive.

made from the pictotone negative, together with the block-out masks, is used to make the *landtone* plate. The positive is made in reverse, that is, wrong-reading, to permit emulsion-to-emulsion contact with the plate.

(7) *Shadowtone printer.* A second contact negative is made from the master positive, but unlike the negative used for the vegetone plate, this negative is overexposed and overdeveloped, to close up the highlights and middle tones. This pictotone drop-out negative, as it is called, can then be used, with the block-out mask, to prepare the *shadowtone* plate, which will print only the darkest tones on the copy.

5–32. Tone Control

Tone control is basic to the entire pictomap process, and the quality of the finished product depends to a large extent on how well the tonal range at each stage of production meets the established requirements. Because there is so much variation in individual perception and evaluation of tone, it is necessary to establish standards by which the tones can be measured and assigned values.

a. In any discussion of tone control, it is important that the photographic terms relating to this subject be precisely defined. The following definitions are generally accepted in the photographic industry, and are used in this manual.

(1) *Contrast* is the separation of tones in a photograph or negative. When these tones are sharply defined, the contrast is called *high* or *hard.* When the tones blend smoothly into each other, the contrast is called *flat* or *soft.* Some films, such as Kodalith, have been specifically designed to produce high contrast images. Contrast is also affected by development methods and as such, usually is referred to as "gamma".

(2) *Density* is the *relative* darkness, or light-stopping quality, of one tone when compared to another, or to a scale of tones. The darker a tone, the higher its density. Shadow areas on a positive have a high density; on a negative of the same copy, they have a low density.

(3) *Gray scale* is a series of tones which range from white to black with a progressive, and measurable change in density between each step and the next. It is used for visual comparison and evaluation of the tones on the copy. White usually is assigned a value of zero and all other tones on the copy are expressed in relation to that value. The number of steps in a gray scale can be varied to meet the needs of the type of work. In pictomap processing, a ten-step gray scale has given reliable results.

(4) *Densitometers* are mechanical devices for measuring the density of photographic copy. There are two general types of densitometers: visual and photoelectric. In the visual type, the tone being measured is visually compared to a control tone, the density of which can be adjusted to match the one being measured, and its value then read on a calibrated scale. The photoelectric type, as its name implies, measures the density of tones by means of a photoelectric cell, similar to those used in light meters. Some densitometers are designed to measure the light passing through, or transmitted by, a negative or positive. Other types measure reflected light. For pictomap work, a densitometer must be the transmission type.

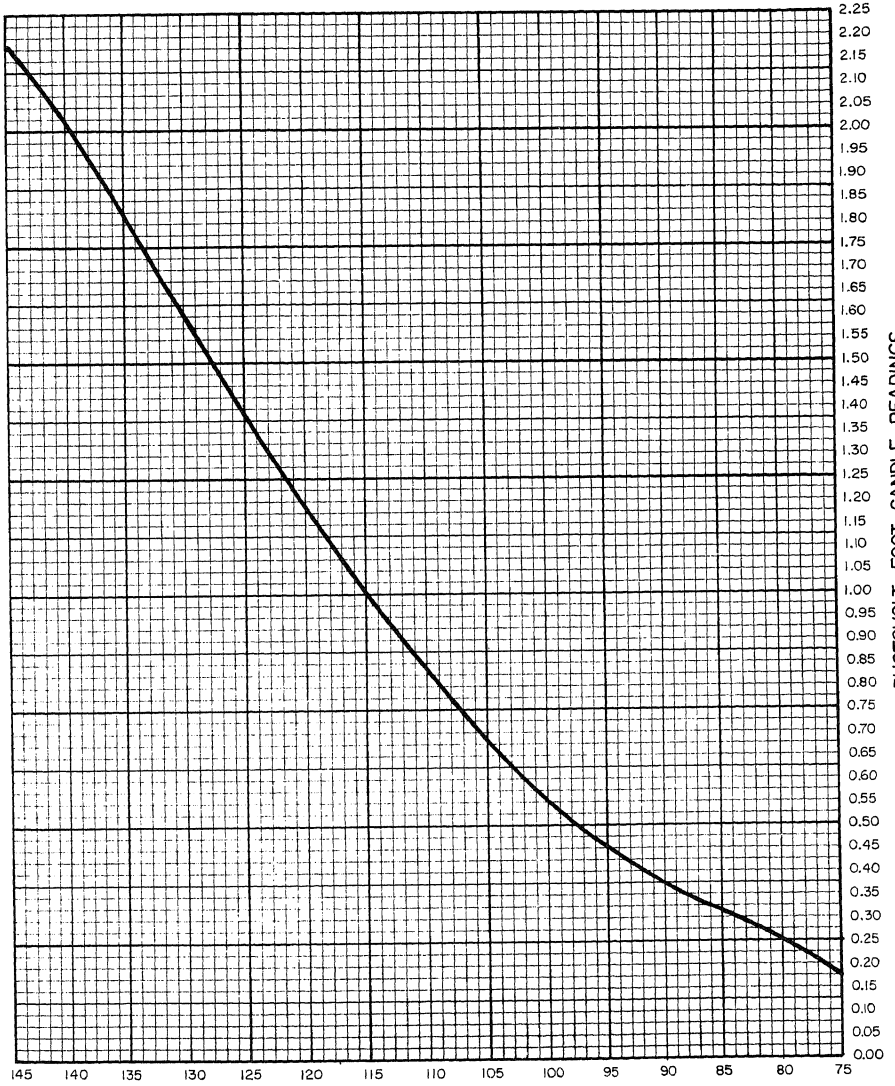
(5) *Density range* is the numerical difference between the maximum and minimum densities of a photo or negative, expressed in terms of a gray scale, or the calibrations of a densitometer.

b. Regardless of the method used for measuring density, it is important to establish the density range of the original photomosaic, because this is the basis for determining the length of exposure, amount of light, and developing time necessary to achieve the desired contrast and density of the copy at each stage of processing.

(1) The ideal copy for pictomaps should have normal contrast and a density range of about 1.50. This is the range desired for the first generation camera negative of the original photomosaic. Satisfactory copy for pictomaps has been prepared from mosaics with a density range as low as 1.00, and as high as 2.00, by varying exposure and development times.

(2) The density range for the 80% ± positive mask should fall between .15 and .25. If there is too much contrast in the original, the lower density helps to flatten out the detail; for flat copy, the higher density heightens shadow detail.

(3) The preparation of the master positive is the first stage of the process that uses high contrast film. The image on high contrast film jumps sharply from low to high density as a result of a slight increase in exposure, reproducing clean, sharp lines from the soft grays of continuous-tone copy. Hence, this stage of the process is given a long exposure. To avoid high gamma, or development contrast, however, and to retain as much pattern as possible in all areas of the copy, the development time is cut short. One to 1½ minutes of development is usual.



Light Intensity in foot candles of #212 bulb from 75 to 145 volts, distance 170 inches

Figure 5–17. Effect of voltage on light intensity.

c. Proper evaluation of the copy to establish the correct balance of exposure and development times is essential to the preparation of a pictomap. Time/temperature charts, which are so reliable in certain types of photo processing, cannot be used for high contrast film. These must be developed by inspection. Gray scales and densitometers aid this process, but the skill and judgment of the cameraman remains the determining factor. To provide guidance in establishing optimum processing times for a given pictomap, data from the preparation of a representative pictomap are tabulated in table 5–8. This photomosaic had *normal* contrast, and a good range of highlights, middle tones, and shadows. The light source was placed at a distance of 8 feet from the copyboard. The items shown in italics are those which must be adjusted when necessary to compensate for variations in copy, or distance between light and copy.

d. Control of Illumination. A voltage regulator is necessary to control the amount of light to which the copy is exposed in each step of the pictomap process. Figure 5–17 shows in graphic form the rate at which light intensity increases with an increase in voltage, based on a distance of 170 inches between light source and copy. If conditions do not permit this distance, it is advisable to prepare a similar chart, based on the new distance, to be used as an aid in determining proper exposure times, under the conditions existing at each particular photo lab.

Table 5–8. Processing Data for a Typical Photomap.

	Camera negative (1st generation)	Contact positive (1st generation)	Contact duplicate negative (2d gen.)	80% ± positive mask (2d gen.)	Pictotone master positive	Pictotone negative (vegetone printer)	Pictotone reverse positive (landtone printer)	Pictotone drop-out negative (shadowtone printer)
Film	Kodak Commercial	Kodak Commercial	Kodak Commercial	Kodak Commercial	Kodalith Ortho type 3	Kodalith Ortho type 3	Kodalith Ortho type 3	Kodalith Ortho type 3
Lighting	2 carbon arc lamps.	150 watt bulb.	150 watt bulb.	150 watt bulb.	150 watt bulb.	150 watt bulb.	150 watt bulb.	150 watt bulb.
Voltage	*75*	*75*	*100*	*150*	*100*	*100*	*100*	
Exposure	*15 sec at F/64*	*3 sec*	*3 sec*	*3 sec*	*35 sec*	*5 sec*	*5 sec*	*15 sec*
Developer	Selectol Soft	Selectol Soft	Selectol Soft	Selectol Soft	Hunts Prem Grapholith.	Hunts Prem Grapholith.	Hunts Prem Grapholith.	Hunts Prem Grapholith.
Developing Time	*4 min*	*4 min*	*4 min*	*3 min*	*1 min 40 sec*	*1 min 40 sec*	*2 min*	*2 min 15 sec*
Density range (approx).	*1.50*			*.20*		*1.50.*		

CHAPTER 6
NEGATIVE CORRECTIONS AND PREPARATION OF FLATS

Section I. INTRODUCTION

6–1. General

a. Before the film or scribed negatives of the copy can be used to make the photolithographic plates, they must be corrected wherever necessary, assembled, and carefully positioned on a flat made of opaque masking paper. Although unavoidable minor changes can be made to the press plates, it is quicker, cheaper, and more accurate to make any required corrections to the negatives during the flat preparation phase. These corrections can consist of opaquing out defects or unwanted detail; engraving new or revised linework; stripping in negatives of corrected or screened copy; or adding registration marks. The corrections usually are made before the negatives are assembled and positioned on the flat. In some cases, however, it is preferable to make the flat first, to avoid unnecessary opaquing in nonprinting portions of the negatives which can be masked by the material used for the flat.

b. This chapter describes the equipment used for the correction of negatives and the preparation of flats, methods of negative correction, and procedures for assembling the various types of flats used to make photolithographic plates. The primary emphasis is on map reproduction, but the same procedures are followed in preparing simple or combination flats for other types of military printing. Flats for bookwork and the reproduction of forms are also discussed.

6–2. Safety

a. Sharp tools are necessary for good workmanship. They are also a cause of accidents. Etching tools should not be carried in pockets, nor should they be left lying on the layout table where they can be covered by a flat and accidentally dropped in moving the covering material. Steel triangles and straightedges can also cause foot injuries if they are accidentally dropped.

b. The fumes of some cleaning solvents, such as benzol, are toxic. Such solvents should be used sparingly in layout operations. For film cleaning, highly volatile solvents that have no residue are sometimes necessary, but the quantities required at any time are extremely small. If volatile solvents are used, they should be kept in a small safety container.

6–3. Equipment for Negative Correction and Preparation of Flats

a. Layout Tables. These tables provide an illuminated glare-free working surface on which negatives can be corrected. The working surface is a sheet of glass grained on the underside to diffuse the internal lighting. The internal lighting usually consists of several fluorescent lamps, which are located so as to provide a uniform distribution of light under the area of the glass top. Internal reflectors and diffusers also may be used to improve the uniformity of the light. Figure 6–1 shows an example of one type of layout table.

b. Lineup and Register Table. Layouts requiring an accurate positioning of negatives are prepared on a lineup and register table. This table has an internally illuminated working surface and is equipped with movable straightedges for precision alinement of negatives (fig. 6–2).

c. Pin Register Board. This device is used to punch register holes in negatives and to prepunch plates or film prior to use. Register holes are used in conjunction with a pin register bar or register pins, sometimes referred to as studs, to provide accurate registration of detail in multiple exposure layouts. Hole tabs may also be used. Tabs are available in either round form, to fit the pin exactly, or in slotted form, to allow for expansion or contraction of the negatives without losing alinement (fig. 6–3 and 6–4).

d. Register Pins or Studs. These are plastic or brass rivets with a very thin head used with register holes to afford a fast and accurate means of positioning two or more negatives. Negatives can then be successively exposed in register with each other.

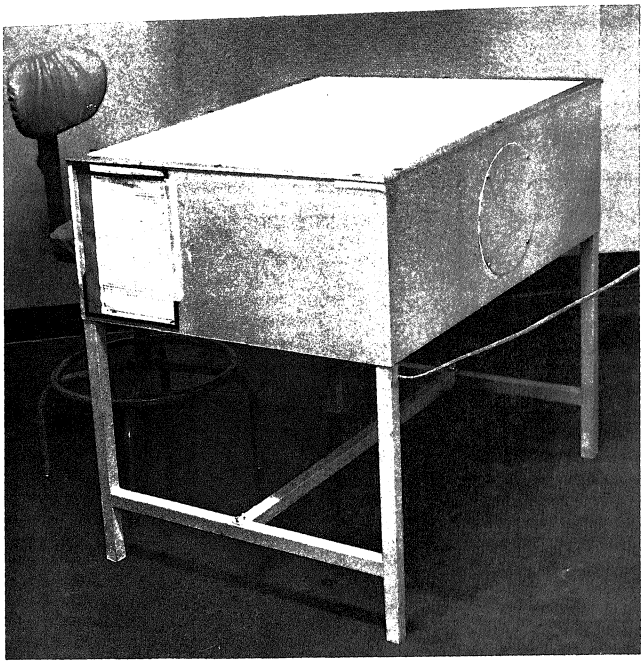


Figure 6–1. A layout table.

e. Dowels and Fitters. Dowels are thin plastic discs with adhesive on one side. They are used with register holes (fitters) to position two or more negatives in register with each other.

f. Rules and Scales. These tools are primarily intended for measurement and not for drawing straight lines. Steel scales with fine etched or engraved divisions are used for precision measurements, while plastic scales may be used for rough work.

g. Straightedge. Straightedges are used for scribing or drawing straight lines. Some straightedges are also calibrated to serve as scales. Straightedges should be handled and used with care. Tools such as scribers, ruling pens, and razor blades should be guided squarely along the straightedge to avoid damaging the edge.

h. Triangles. Plastic and steel triangles are used in layout work for drawing straight lines. Plastic triangles are used only when a high degree of accuracy is not required. A steel triangle should b used for all precision layout and lineup work.

i. Beam Compass. Beam compasses are us when a dimension to be measured or laid off e ceeds the range of the ordinary compass or divi ers. Beam compasses can be used to compa measurements between negatives and to dra accurate right angles or squares. These compass are provided with two heads that can be locked any position along the beam. One head is manual positioned and locked as a starting point. Th other has a micrometer adjustment to set its poi accurately to the desired dimension. Each he will hold a steel point, pencil lead, or pen point.

j. Ruling Pens. Ruling pens are used primari to draw lines for cropping down negative imag with opaquing ink, or for drawing lines on fil positives. When drawing a line, the pen shou first be wiped clean, then partially filled wi opaquing ink. The opaquing ink must be thinne

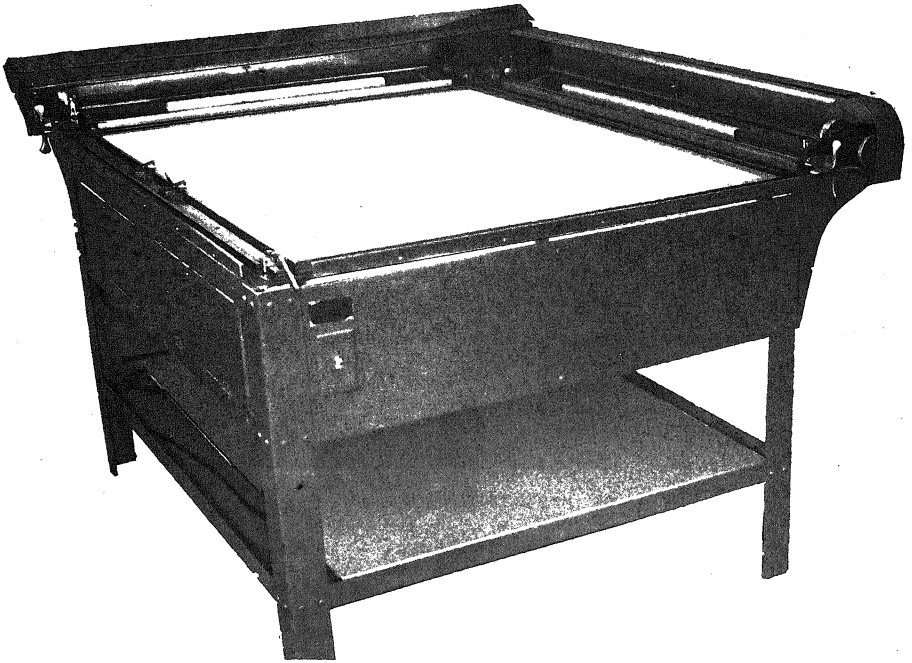


Figure 6-2. Lineup and register table.

slightly to flow freely. The pen must always be held in a vertical position, and tilted slightly in the direction that the line is to be drawn. It should always be adjusted for line width, and tested for smooth flow on waste film immediatly before the line is ruled. In ruling a line, the outside of the nibs must be free of opaquing ink; otherwise, the ink may run and spread under the triangle or straightedge along which the pen is guided. After each use, the pen should be thoroughly cleaned and dried.

k. Etching Tools. Etching tools are used for scraping the emulsion from negatives, for engraving lines through the emulsion, for pricking points on negatives, and for cutting masks and negatives for stripping. The etching tools are available with points of different diameter and cross-sectional shapes. The points are sharpened by grinding and then stoning to the desired shape. Grinding should be done carefully and slowly on a grinding wheel to prevent overheating which could destroy the temper of the point. After grinding, the point must be carefully stoned to a needle point, to a razor edge, or to a scraper edge as required. A fine, hard-rock oil stone is used for stoning.

l. Razor Blades, Knives, and Scissors. Razor blades, knives, and scissors are used for cutting films and masking paper. Single-edged, metal-backed razor blades are used for cutting operations. The thin, double-edge safety razor blades are brittled and may break off or twist when making a cut. These blades should never be used, even if in holders. The craftsman's knife, with replaceable blades, is also used for cutting operations. When cutting film, it is best to cut part way through, on the emulsion side, then bend the film away from the cut so that it cracks along the cut line. If it is necessary to cut all the way through the film, such as for inserting a correction, a clear

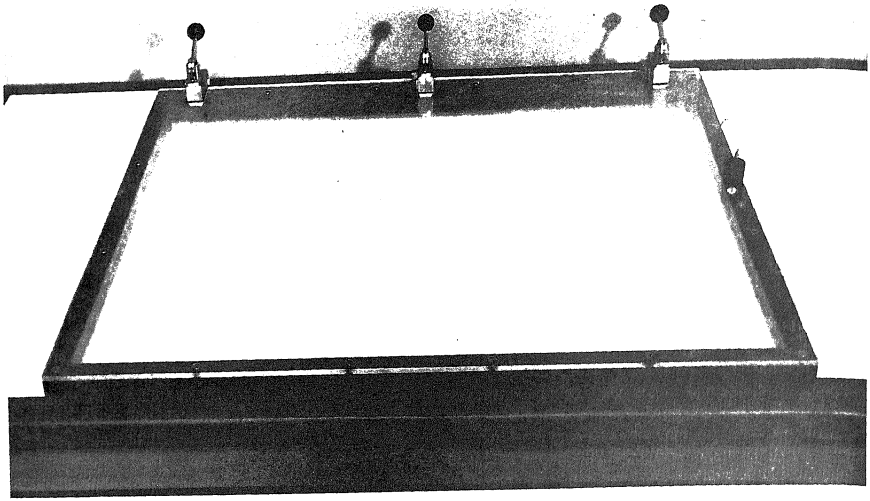


Figure 6–3. Pin register board with register bar and pins.

sheet of waste film or plastic sheeting should be placed under the film to prevent the blade from scratching the glass.

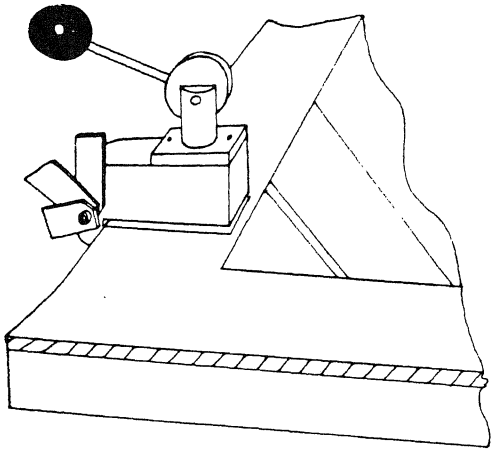
m. Magnifiers. Magnifiers are used to magnify fine detail in the negatives, and are provided in 1.4, 7 and 12 powers of magnification. The low-power magnifier is useful for opaquing out pinholes and defects in negatives, such as between rows of type. The higher power magnifiers are helpful for fine detail work with an etching tool, such as repairing halftone dots or altering fine map symbols.

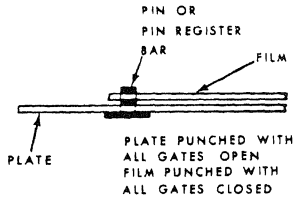
n. Tape. Pressure-sensitive plastic tapes are used for securing film sections together, masking film, and attaching goldenrod paper to layout flats. If the tape is red or black, it can also mask the film joints at the same time. The red tape is translucent and permits visual inspection of cropped printing areas or blocked out type. Transparent tape may be used to attach goldenrod paper to layout flats. The tape will be clean and easily accessible if kept in dispensers.

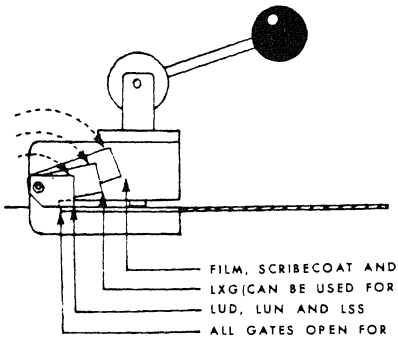
o. Goldenrod Paper. Goldenrod is a clay-coated paper used for preparing negative flats. It serves as a drawing surface for preparing the layout, as a support for holding the flat together, and as a mask for protecting the nonprinting areas of the press plate. Its color prevents the passage of nearly all actinic light during platemaking exposures.

p. Opaquing Ink. Red and black opaquing inks are used to block out defects or unwanted details from negatives, or to retouch printing detail in positives. Black, colloidal-graphite opaquing ink is used for fine work as it covers well and is extremely thin. It is better for working on areas which are to be scribed. Red opaquing ink is easier to apply over large areas. It must be applied carefully and uniformly.

q. Master Template. A master template, used as an aid in layout work, represents the actual press plate (fig. 6–5). It is made of a transparent sheet of polyester-base film and shows the press sheet outline, the press sheet horizontal center line, the plate and press sheet vertical center line and the press cylinder line (para 6 *9b* through *d*). The utility of the template is greatly increased if it is divided into a .50-inch or .10-inch grid, with the 1-inch lines numbered progressively from the centerlines outward. The edge should be punched to match the pin register bar furnished with the pin register board. The template holes should be punched with great care and precision, since any errors in their positioning will affect every flat for which it is used as a guide, and will necessitate extra adjustments on the press during every make-ready.







ABOVE - PUNCH AND ADJUSTABLE GATES

BELOW - USE OF PUNCH GATES TO ADJUST REGISTRATION OF REPRODUCIBLES TO MEET THE MECHANICAL REQUIREMENTS OF DIFFERENT MODELS AND SIZE PRESSES

Figure 6-4. Pin register bar and pin.

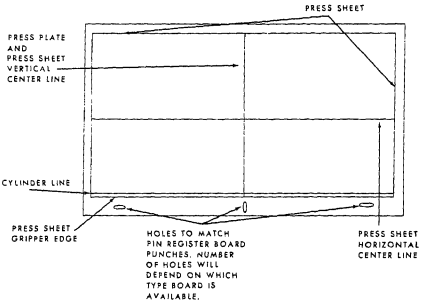


Figure 6-5. Master template for alining reproducibles.

Section II. NEGATIVE CORRECTIONS

6-4. Characteristics of Good Negatives

A satisfactory negative is correctly scaled to the specified dimensions and has uniform density, good resolution and sharp definition of detail, adequate opacity of background, and clear, clean transparent (image) areas. These properties must be checked before proceeding with corrections and flat preparation, since a relatively small additional effort spent in the camera section to correct or eliminate deficiencies may eliminate hours spent opaquing the negatives. In examining negatives, check the following qualities:

a. Coverage. Image includes all detail to be reproduced.

b. Uniformity. Density of negative background, weight of type characters, and drafted details are uniform over the entire negative. Negatives that show decreasing density toward the edges, thickening or coalescing of lines, or fog in clear areas should be returned to the camera section for correction.

c. Definition. All image detail is sharply and distinctly defined. Clearly defined images are necessary to print fine type and lines without blurring, thickening, or filling-in of detail.

d. Size. The side and diagonal dimensions of the image area on the negative are accurate within specified tolerances. Check the dimensions of all sides and diagonals with a beam compass. Dimensions of individual negatives in a set of negatives for multicolor printing must be within 0.01 inch of computed dimensions to insure accurate registration of colors.

6-5. Opaquing

Opaquing material, usually referred to as "opaque", prevents the passage of light through the clear portions of films. It is applied to negatives to spot out pinholes and other defects, to crop image areas to size, and to remove undesired marks from the text. The use of opaque on positives is limited to correcting broken printing detail and to adding lines and solid printing areas. Opaque can be applied with watercolor brushes, ruling pens, special fountain pens, and fine-nib pens, such as crowquill or lithographic pens. Opaque may be applied to either side of a negative. For ordinary spotting out, ruling, and cropping of image areas, opaque is best applied to the back (nonemulsion side) of the negative. In this way, opaquing errors, such as accidental strokes into the image area, can be wiped away without damage to the image. In addition, possible cutting of the emulsion by the ruling pen is avoided when lines are ruled on the back side. For very close work, such as retouching defective text characters or halftone dots, the opaquing must be done on the emulsion side of the film to prevent undercutting during platemaking exposures.

a. Types of Opaques. A variety of opaques are available. These usually are obtained as a cake, paste, or as a heavy liquid which is thinned down with water or solvent to working consistency. The following types of opaques are used in military reproduction units.

(1) Water-soluble, black colloidal-graphite opaque is used for fine detail work, since it covers well, and is extremely thin. This opaque should not be used on negatives that will be stored for 3

months or longer under normal conditions, as the opaque becomes brittle and will flake off during handling. The flakes are difficult to detect and may block out some other portion of the image area.

(2) Water-soluble, red opaque is used for negatives not requiring close registration between features. This opaque is easier to apply over large areas, but, owing to its density, generally is not suited for fine work. If applied on the emulsion side close to halftone areas or fine line detail, the thick layer of opaque can prevent contact between the negative and the plate.

(3) Turpentine-soluble opaques are used where added durability is required, as for repeated exposures in a vacuum frame. These opaques can also be applied on the emulsion side where the temporary masking of detail is necessary. The temporary areas can then be wiped away with alcohol or other chemical cleaner without disturbing the permanently opaqued areas on the other side.

b. Opaquing Procedure. The methods of working with opaque to make it free-flowing in a brush or pen are as follows.

(1) Pour a small quantity of opaque into a shallow dish, container, or palette. Add water to achieve working consistency; usual dilution is about 50 percent water.

(2) Pour contents of one jar into a container approximately twice the capacity of the jar and dilute with as much water as the original jar holds. Keep this mixture fluid by adding water as it evaporates and by occasional stirring to maintain consistency.

(3) Pour a small amount of opaque into a shallow dish or tray and allow it to harden to form a cake. Use the opaque by dipping a brush into clean water and working it over the cake to obtain the proper working consistency.

(4) For brush application, opaque should have the consistency of light cream to cover an area completely in one stroke. The opaque should not transmit light or form lumpy streaks. Lumps or ridges indicate insufficient dilution; thin, translucent streaks indicate excessive dilution or insufficient mixing. When used in a ruling pen or nib pen, the opaque is further diluted by a small amount so that it will flow smoothly, yet be completely opaque.

(5) Clean brushes and pens are essential for the correct application of opaque. Since opaque dries rapidly, it must be used immediately after dipping the brush or filling the pen. When using the brush, wipe off the excess by drawing the brush across the rim of the container, and test it for smooth application on a waste margin of the film. When using a pen always test the flow on a waste piece of film immediately before applying. If it is difficult to start, draw the point across the edge of the film or over a small piece of chamois. If the opaque starts but does not flow smoothly, it may still be too thick or the pen may be clogged. When this difficulty is experienced, clean the pen thoroughly, refill it, and try it on a clean piece of film. If the irregular flow still persists, thin the opaque slightly and test it again. Greasy fingerprints can also interfere with the flow.

(6) When applying opaque to negatives, use sheets of goldenrod or black paper around the negative to reduce the light glare. This will prevent eye strain, and make the defects easier to see. In addition, an overhead light of reduced intensity is necessary to observe the proper application of the opaque.

(7) For spotting out pinholes and minor defects, use a No. 1, 2, or 3 brush. Begin by spotting out all defects in the central area and gradually work down over the front half of the negative. Then, turn the negative around and spot out the remaining half. For fine work, the opaquing should be done on the emulsion side. Fast, general opaquing is best done on the back of the negative, as errors are easier to correct. The opaquer should not rest his hand directly on the negative, but should use an arm board or a clean blotter.

(8) When correcting broken text characters or halftone dots, work on the emulsion side and use a magnifier. With a crowquill pen, the dot size can be approximated by pen pressure, but cannot be expected to duplicate photographic quality. The careful location of dots in approximately the same screen pattern and in the same size as the adjacent dots can, however, produce inconspicuous corrections.

(9) To crop an area to size with opaque, first, draw the borders by ruling a line between crop marks on opposite edges of the negative. Border lines should have a minimum line weight of 1/32 inch to 3/64 inch, since thick lines are easier to opaque up to with a brush. Using a No. 6 or No. 8 artist's brush, apply opaque starting just beyond one corner of the border. Press the brush down so that it flattens slightly against the negative with the inner edge of the brush just touching the border line. Move the brush smoothly and steadily along the border. Do not apply too much pressure on the brush, as this will exhaust the brush before the line is finished. Opaque the border for at least

½ inch to permit the masking paper to be cut at least ⅜ inch away from the cropped area.

(10) If an error occurs in applying opaque, correct it immediately so it is not forgotten and allowed to block out part of the desired image. Use a clean, damp cotton swab, wiping from inside toward the border. Turn the swab over or replace the cotton after each wipe to prevent smearing.

6–6. Negative Engraving

a. Principles. The photographic negative consists of a thin, transparent plastic sheet coated with a sensitized emulsion, on which a transparent image has been imposed by exposure to light (para 5–12). A scribed negative, which is used in the same way as a film negative, is prepared by mechanically cutting through an opaque coating to expose transparent areas of the base plastic. Both are revised or corrected by cutting or engraving new lines into the emulsion or coating of the negative. The engraving tool must remove the emulsion cleanly and completely to produce well defined, transparent image areas. Properly used, it removes a continuous shaving with each stroke. A flat, hard work surface, such as the glass top of a layout table, must be used to do quality engraving. A soft or resilient surface, such as a sheet of paper, results in embossed distortions and irregular lines. The work surface must also be free from scratches, dust, and specks of opaque or other materials. The negative to be engraved must also be clean and free from lumps of opaque, dust, or bits of tape. In addition, the emulsion of a film negative must not be too brittle. A negative that has been excessively hardened in processing, or that has been dried rapidly over heat, may not scribe cleanly, since the emulsion will chip away and leave a ragged line. This condition is corrected by placing the negative in a box with a damp blotter to soften the emulsion. To avoid contact, staple the blotter to the box lid. If opaque has not been applied, it is better to soak the negative for about 5 minutes in a solution of 3 percent glycerine and 97 percent water. Where extensive negative scribing will be required, it is usually best to request the camera section to use a nonhardening fixer during processing.

b. Engraving Points. Lithographic etching needles are used for engraving on photographic emulsions. These needles are available in various diameters and cross-sectional shapes, and must be ground and sharpened to the desired width and fineness. This is determined by the intended use of the point (fig. 6–6). The cutting quality is dependent on the sharpness and shape of the point, the angle at which it is held, the direction of movement when cutting, the amount of pressure applied, and the skill of the user. The most important quality of the tool is a properly sharpened point. A dull engraving point furrows the emulsion and produces a ragged line. Diamond-shaped or oval-pointed needles must be used carefully, as variations in pressure, or in the angle of scribing, change the dimension of the line.

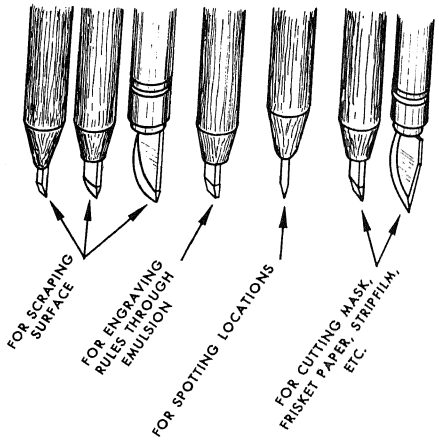


Figure 6–6. Engraving and etching points.

(1) A sharp, round point is used to engrave a clean line through soft emulsions which have a hard base, such as glass. These points are also used to mark points along a scale and to transfer points when two plastic base negatives are placed in register on top of one another. When working with very small pieces of film, this type of point can be used as an aid in picking up or sliding a small piece into position. To sharpen these points, roll the holder between the palms of both hands, and keep the point in contact with the oil stone at an angle of approximately 30°. The finished point should be conically shaped with a very fine tip.

(2) A flat, wedged-shaped point is used to engrave lines, to correct type characters, and to scrape open-window areas in emulsions on a soft base, such as polyester and polystyrene plastic bases. The conical point must be ground flat, in the

same manner as a carpenter's chisel. Each side is then sharpened by holding the point at a constant angle to the oil stone. To put a fine edge on the point, hold it parallel to the stone and use a rocking, pendulum motion. The point is finished by holding it perpendicular to the stone and using a slight rocking motion to bevel the top without destroying the cutting edge. Test the finished point on a piece of film. If it does not produce satisfactory results, repeat the sharpening procedure. The finished point is quite versatile. It can engrave lines by holding it perpendicular to the surface and moving it along a straightedge. At approximately a 60° or 70° angle to the film, the point can be used free hand to correct type characters and cartographic symbols. Large areas of the emulsion can be "spaded" (scraped) out by holding the point at approximately a 10° to 15° angle to the film.

(3) Lines are engraved on negatives to—

(*a*) Clean up defective rulings or other line detail.

(*b*) Prepare ruled forms.

(*c*) Add borders or enclose specified bodies of text.

(*d*) Produce a continuous line across an assembly of several negatives.

(4) To engrave lines on negatives, the following procedure is used:

(*a*) Place the negative to be engraved, emulsion side up, on the layout table. Square the negative with a straightedge and tape it to the table top.

(*b*) If any of the lines will pass through photographic defects, such as pinholes, spot the defects, using a colloidal-graphite opaque.

(*c*) If a precision layout table is used, the locations for the lines can be read directly on the scales or on the micrometer dials. Otherwise, it will be necessary to indicate the location of each line to be drawn. The location of each line is marked along the margin of the negative, using a pair of dividers or engraving point and steel scale. For forms, a previously printed copy of the form can be used for line locations. The printed form is squared with, and taped alongside the negative. A straightedge can be positioned on the printed lines and the equivalent lines engraved in the film. If the printed form was previously printed by letter press using tape rules, the lines should be checked for alinement since the rules may have been deformed when set up for printing.

(*d*) Once the locations are determined, the lines are engraved as required. Any line can be widened by tilting the tool slightly, without moving the straightedge, and engraving a second line so that it overlaps the first and thus increases its thickness to the required amount.

(5) Although engraving is usually done on negatives, register marks or fine lines can also be engraved on positives and filled in by rubbing a black crayon (litho or grease pencil) across the line. The excess is then wiped away with a clean tissue or rag across the line rather than along it to leave a deposit in the line.

(6) Scribe-coated negatives which require extensive engraving corrections are usually returned to the photomapping units. The special equipment and techniques needed for scribing on coated plastic are discussed in TM 5–240.

6–7. Stripping

Stripping is the process used to combine parts of two or more photographic films to make one complete revised film. The item to be revised is cut out of the film and is replaced by inserting (mortising) the new item in the cut out space. To insert a revision, first tape the new item in its proper position on the film. Place the negative and the attached insert over a clear sheet of heavy waste film on the layout table. Using a razor blade, cut the opening for the insert. Tilt the blade slightly, so that the cutting edge angles away from the insert (fig. 6–7). This results in the film opening being slightly larger than the insert. Use light cuts; heavy cuts can distort the film and cut it out of true. Lift out the portion to be discarded and turn the negative emulsion side down on the layout table. Aline the insert in position and attach it to the film with strips of tape. Use pressure-sensitive, red cellophane tape to join the films and cover the gap.

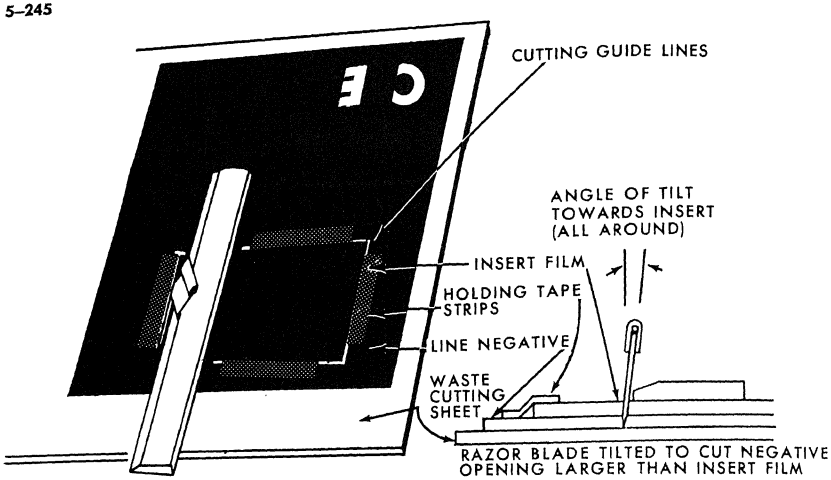


Figure 6-7. Cutting film insert.

Section II. PREPARATION OF FLATS

6-8. Layout Procedures

a. One of the essentials of good printing is proper layout. As used in this manual, the term "layout" means the exact positioning of the reproduction film, within specified dimensions on the masking paper. This is called a "flat". The limiting dimensions are determined by the maximum printing area on the press to be used. Other factors to be considered during flat preparation are the direction of the paper grain, the location of printing subject for uniform ink distribution during the printing phase, and the binding and trimming requirements.

b. There are three basic types of layouts, simple, combination, and multiple color. One of the most common forms of simple layout in military printing is that used to print a single-color map sheet on a field press. Combination layouts include book signatures and multiple image plates produced by photo composing machines. Multiple color printing in military units is almost entirely confined to the reproduction of multicolor maps.

c. The layout can be made directly on the press plate, but it is more frequently prepared on masking paper. The operations required to make a proper layout are: assembling the negatives in correct sequence (when composite or multiple images, or multiple colors are to be printed), establishing the dimensions on the masking paper, affixing the negatives on the masking paper in correct alinement, and removing the masking paper from the image areas that are to print.

6-9. Simple Layout

A simple layout is the proper placement of a single negative on masking paper so that it will fall into the desired printing location on a printing plate. It is a basic layout, the steps of which are repeated in all other layouts. The steps in making a simple layout are as follows:

a. Alining Masking Paper. Select a sheet of masking paper (usually 28 x 30 in.) equal to or slightly larger than the press plate. Position the masking paper on the layout table by alining the long side of the sheet closest to you, which will be designated the *gripper edge*, with a T-square (fig. 6-8). The side on your right is called the *guide* side; the side on your left is called the *offside*; the long side opposite you is called the *tail edge*. If the power edge is frayed or uneven, trim with a sharp cutting edge, using the T-square for a guide. Make certain that the sheet is resting flat on the layout table without bulges or waves. Tape the masking paper to the table top. Take care not to shift or bulge the paper when applying the tape.

b. Cylinder and Paper Lines. Each type of press has a fixed distance on the impression cylinder known as the cylinder clamp area in which no printing can take place. Determine the cylinder clamp dimension of the press for which the layout is being prepared. Draw a line parallel to the gripper edge and at a distance from the gripper edge equal to the cylinder clamp dimension. This line is the cylinder line. Measure 5/16 inch down from the cylinder line and draw a line parallel to the cylinder line. This is the bottom paper line and represents the limit of the printing area. The area between the cylinder line and the bottom paper line is the gripper margin. Within this narrow area, the gripper fingers grasp the paper and carry it through the press. No detail can be printed in this area.

c. Vertical and Horizontal Centerlines. The vertical centerline (fig. 6–8) must be located and marked next. Measure the width of the masking paper and mark the center of the sheet. Then draw the vertical centerline across the sheet. This vertical centerline must be at exact right angles to the cylinder line and extend to the top edge of the sheet. The horizontal centerline is drawn parallel to the bottom paper line and at a distance from the bottom paper line equal to one-half the press sheet width.

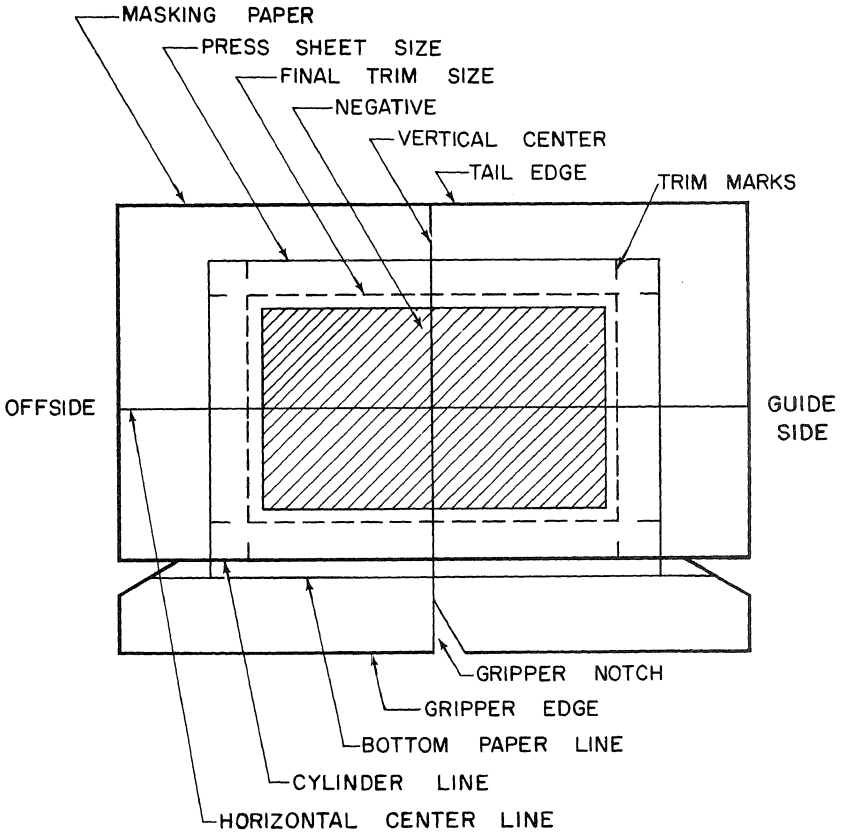


Figure 6–8. Completed simple layout.

d. Press Sheet Outline. Next, the outline of the press sheet is drawn on the layout. The bottom paper line, previously drawn, is the bottom line of the press sheet. The width of the press sheet is measured from the bottom paper line and marked. Draw a line through this mark and parallel to the bottom line. Dimensions equal to one-half the overall press sheet length are measured and marked to the right and left of the vertical centerline to establish the press sheet length. Lines drawn through these marks and parallel to the vertical centerline complete the press sheet outline.

e. Trim Size. The length and width dimensions of the trim size are measured from the vertical and horizontal centerlines, respectively, and normally are centered within the outline of the press sheet. Next, draw trim marks to aid in cutting the press sheet. Trim marks are drawn as short lines from ¼ to ½ inch long that are located outside the trim size area and just inside the edges of the press sheet (fig. 6–8). These marks will later be scribed or cut into the negative.

f. Image Position. Trim excess film from the negative and place the negative, emulsion side up, in its approximate position on the masking paper. Establish margins as specified for the job and move the negative into alinement. Make certain that the negative is flat and free from bulges, then tape the negative to the masking paper. After taping, check to see that the negative is still alined.

g. Trim Marks. Trim marks (*e* above) are cut into the negative next. Make small cuts approximately 0.25 inch long at each corner of the trim size. The trim marks previously drawn on the masking paper are used to aline the cuts. These cuts will appear on the printed sheet as small tick marks which will be used as guides to trim the sheet to size after printing.

h. Exposure Openings. Unfasten the flat from the layout table and turn it over. It is now necessary to cut exposure openings in the masking paper for each printing area. Use a razor blade to cut around each printing area, keeping the cuts about ⅜ inch to ½ inch away from printing detail. Allow the masking paper to remain over nonprinting areas of the negative. Also cut out openings over each trim mark that is to be exposed on the press plate. Tape down any loose paper edges along the cut-out openings to prevent damage to the mask during handling and storage.

i. Press Plate Position Notches. These notches are based on the cylinder line and the vertical centerline as drawn on the layout. Make certain that these lines extend to the edge of the masking paper. These lines are notched to expose the margins of the press plate. Cut a half V-notch in the edge of the masking paper at each end of the cylinder line. These notches are the cylinder notches and are used to aline the press plate on the press cylinder. Cut a similar notch along the vertical centerline at the bottom edge of the masking paper. This notch is the gripper notch and serves to locate the centerline of the flat in platemaking (fig. 6–8).

j. Opaquing. Spot out all pinholes and negative defects with opaquing ink and brush. Opaquing techniques are described in detail in paragraph 6–5.

k. Final Check. Check all written instructions to insure that each requirement has been complied with. Inspect the completed flat to see that all register, trim, and other reference marks have been added to the flat. As a final check, have the flat checked by the supervisor or another person. Inspection by another person often discloses errors that may be overlooked by someone too familiar with the job.

6–10. Combination Layouts

a. A combination layout is an assembly of negatives of identical or different subjects used to prepare a single pressplate for monochrome printing. In military printing, combation layouts are used primarily for bookwork and forms. Although all combination layouts are not identical in composition, certain basic factors must be considered for each layout. These factors are—

(1) *Press run.* Combination layouts containing subjects that require a different number of

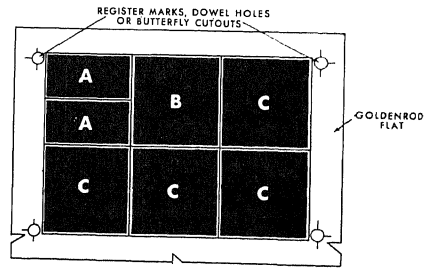


Figure 6–9. Negatives ratioed to press run.

impressions for each negative can be prepared by using a ratioed quantity of duplicate negatives on the flat. For example, to print 40,000 impressions of Form A, 20,000 impressions of Form B and 80,000 impressions of Form C by a single press-run, a combination layout containing one negative of Form B, two negatives of Form A and four negatives of Form C would be required (fig. 6–9). Using this layout, the required number of forms can be printed by a single press run of 20,000 impressions.

(2) *Mechanical limitations of press.* The layout cannot exceed the maximum image size or sheet size of the press for which the flat is being prepared. Table 6–1 lists the mechanical limitations of some of the standard offset printing presses used by Army units. Another mechanical limitation is the ink distribution system of the press. An ink distribution system can be adjusted only along the lengthwise dimension of the rollers. If the layout contains large solid or other ink-consuming areas, the negatives must be arranged in a pattern that will place image areas of equal ink density on the same side, perpendicular to the leading edge of the press sheet (fig. 6–10).

Table 6–1. Mechanical Limitations of Standard Military Offset Printing Presses

	Harris LXC	ATF Model D2	Harris LUD (Model 145A)
Maximum printing area (inches).	22⅝ x 29½	22⅛ x 29½	35⅝ x 47½
Maximum sheet size (inches).	23 x 30	22½ x 30	36 x 48
Minimum sheet size (inches).	9 x 12	11 x 17	17 x 22
Plate size (inches.	27 x 30	27¼ x 30	40 x 48

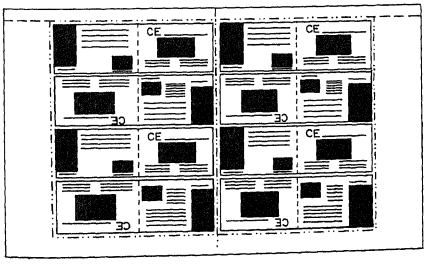


Figure 6–10. Negatives arranged to aid ink distribution.

(3) *Color of ink.* Only subjects that are to be printed in the same color can be included on a combination flat, as the standard offset printing presses used by Army units are capable of printing only one color per press run.

(4) *Paper stock.* It is impracticable to print on paper stock of various thicknesses during a single press run, as the press must be adjusted for each type of paper stock. A combination flat can include only subjects that will be printed on the same type of paper stock.

(5) *Cutting operations.* The arrangement of negatives on a combination flat should utilize the maximum press-sheet size but must be so arranged that a minimum number of cuts is required to trim the printed sheets. The arrangement of subjects for cutting is dependent on the trim size of each subject and the capabilities of the paper cutter (fig. 6–11).

(6) *Folding and binding.* If the printed sheets are to be folded, the negatives must be correctly located and headed on the flat to provide for proper sequence after folding. Proper arrangement is also necessary for the accurate alinement of work which must be printed back-to-back and then bound in sequence (for example, bookwork).

b. The layout procedure for a combination flat is basically the same as for any other flat. The basic reference lines are drawn first. The negatives are then inspected for centermarks or trim marks that can be used to aline the negatives in position on the flat. Centermarks are preferred but trim marks can be used. In the absence of such marks, features such as border lines, justified margins, or headings, if common to all negatives, can be used. The following procedures are used for layouts based on centermarks and on trim marks.

(1) *Layouts based on negative centermarks.* For simple combinations of same-size negatives, refer to the job instructions and note the trim size of each negative, and the paper grain direction, if it is a factor. The job instructions usually specify the number-up on the sheet, such as 6-up, 8-up, or 12-up. By comparing the paper sheet dimensions with the dimensions of the form, and considering

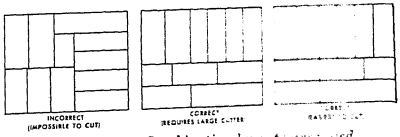


Figure 6–11. Combination layouts arranged for cutting.

the number-up specified, determine the best arrangement of the negatives. The centerline for the first row of subjects along the gripper margin is drawn next. To do this divide the vertical trim size of the negatives by two and add to it any trim margin required along the gripper edge. Mark this distance up from the bottom paper line. Then draw the horizontal centerline for the first row so that it will pass through the mark and parallel to the bottom paper line. Next determine the distance from the bottom paper line to the centerline of the second row. This will be the distance previously determined for the first row, plus the full vertical trim size of the negative and any specified double-trim allowance between the negatives (fig. 6–12). Mark this distance up from the bottom paper line and draw a line through the mark, parallel to the bottom paperline. Repeat this procedure for all remaining horizontal centerlines. The vertical centerlines of the subjects are located next. If an odd number of negatives are located along the bottom paper line, such as 3, 5, or 7, the centerline of the sheet is also the centerline of the middle row (fig. 6–12). The centerline for the next vertical row to either side is located at a distance equal to the horizontal trim size of the negative, plus any required double-trim allowance between negatives. Mark this distance and draw the centerline through the mark and parallel to the centerline of the sheet. Calculate the location of the next two outer rows. This will be two times the horizontal trim distance plus two times any required double trim between negatives. Mark and draw the vertical centerlines as before. Repeat these procedures for the remaining vertical centerlines, making all measurements from the vertical centerline of the sheet. For layouts with an even number of negatives across the sheet, the centerline for each of the two central rows is located at a distance from the centerline of the sheet equal to one-half the horizontal trim size of the negative (fig. 6–13). Mark these lines and draw the vertical centerlines. The next two vertical rows are located at a distance equal to one and one-half times the horizontal trim size of the negative. Again, mark and draw the vertical centerlines. Repeat these procedures until all vertical centerlines are drawn.

(2) *Layouts based on negative trim marks.* If there is enough margin between the image on the negative and the negative trim line, the bottom paper line can be used as the edge of the bottom row of subjects and no other bottom trim line is necessary. If the margin on the copy is very narrow, however, this is not practical, and a bottom

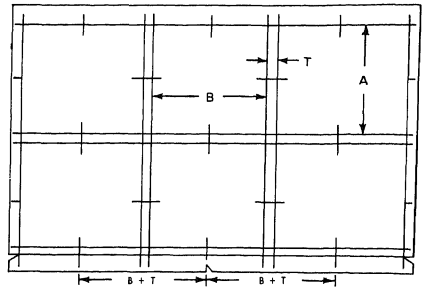


Figure 6–12. Vertical centerline layout (odd number across).

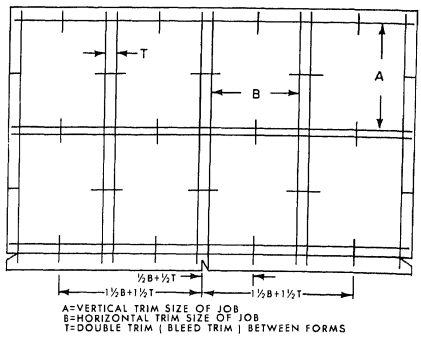


Figure 6–13. Vertical centerline layout (even number across).

trim mark is needed, to insure that no detail will extend into the gripper margin (fig. 6–14). Mark the position of this bottom trim line by measuring at least ⅜ inch up from the cylinder line. Then draw the bottom line through the mark, parallel to the cylinder line. Refer to the job instructions to determine the trim size for the subjects. Add the vertical trim size to the trim allowance. Measure this distance from the cylinder line and mark the dimension on the layout. Draw a line through each mark, parallel to the cylinder line. The next horizontal trim line is located at a distance equal to two times the full vertical trim size, plus the trim allowance. Mark this distance up from the cylinder line. Draw horizontal lines through these marks. This procedure is repeated for all horizontal trim lines. The vertical trim lines are located

and drawn next. For an even number of negatives across the sheet, the sheet centerline will also be the trim line for the center side of the two central vertical rows of negatives. Draw vertical lines through these marks. Add the specified horizontal trim size of the negative. Measure this distance to both sides of the vertical centerline and mark the distance on the layout. Draw vertical lines through these marks. Repeat this procedure for the remaining vertical centerlines, measuring all distances from the vertical centerline of the layout. For an odd number of negatives across the layout, the trim lines for the central vertical row are located one-half the specified horizontal trim size of the negatives to both sides of the centerline. Mark this distance on the layout. Vertical lines are then drawn through these marks. The location for the next vertical trim line is equal to one and one-half times the specified horizontal trim size. Mark these distances to both sides of the centerline. Draw vertical lines through these marks. These procedures are repeated until all required vertical centerlines have been drawn.

(3) *Check dimensions.* Inspect all centerlines and trim lines for any noticeable error such as an apparent separation between double-trim lines. Using a beam compass, or a strip of paper with the specified trim size marked on it, step it across each negative for an approximate check to catch any serious error. Do this both horizontally and vertically. Check also to see that none of the negative extends outside the press-sheet size outline.

(4) *Add reference lines.* Mark the location for the following reference lines if they do not already appear on the negatives.

(*a*) *Trim and fold marks.* To aid in folding and cutting the press sheet, short lines ½ to 1 inch long are located outside the trim size areas of the negative, and just inside the edges of the press sheet. These marks are later scribed into the negatives or on small tabs of film attached to the flat over the marks (fig. 6–15).

(*b*) *Press sheet centerlines.* These are centered along the edges of the press sheet, preferably outside the trim margin of the negatives. Film tabs with crossmarks are attached in position to these lines (fig. 6–15).

(5) *Nonsymmetrical combination layouts.* If the subject negatives are of different sizes, or are arranged in staggered locations, or have differing head directions, the calculations for the location of each are more complex. To locate each subject in relation to the basic reference lines, first mark a rough sketch showing the shape, location and head direction of each subject to be printed on the press sheet. Mark the trim size of each subject. Total the overall distances at different locations across the layout where the sum of the individual dimensions may vary. Based on the maximum dimensions obtained, determine if it is desirable to in-

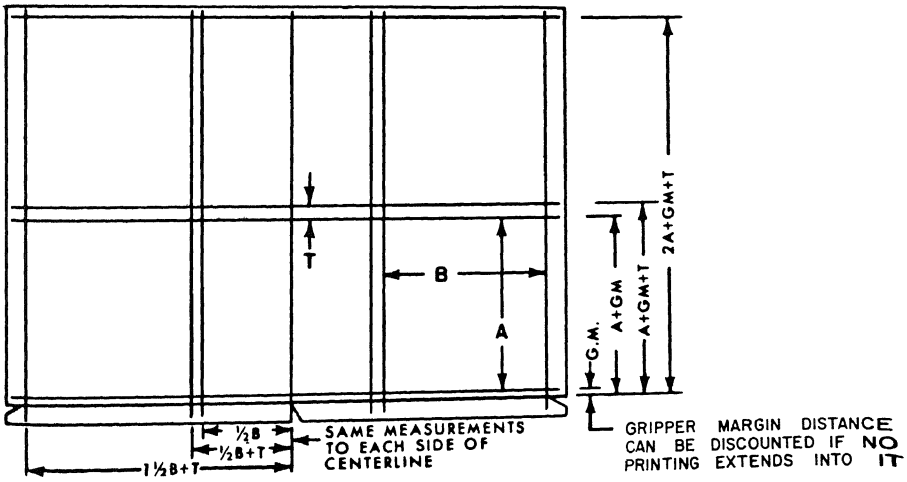


Figure 6–14. Layout based on negative trim marks.

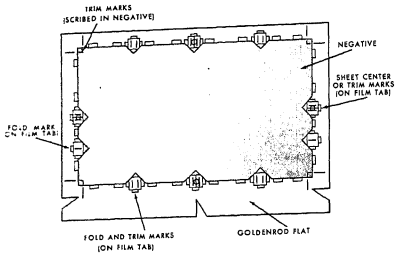


Figure 6-15. Trim, fold, and center marks.

crease the trim allowances between any negatives to reduce the number of cuts (fig. 6-16). Draw an outline to indicate the total area of the negatives on the press sheet. A gripper-trim allowance is usually included in this outline, because in many combinations at least some of the negatives along the gripper edge will bleed into this extra trim. This trim allowance is therefore extended to all the negatives that print along the gripper edge so that a straight trim can be made. The location of each subject is drawn next on the layout. If the central subject is exactly centered, or if its vertical edge coincides with the vertical centerline of the layout, the location of this subject is drawn first. For other combinations it is easier to work from one of the corner subjects along the gripper edge. Location of subjects is based on negative centerlines or negative trim marks, as applicable. If centerlines are used, the horizontal centerline of the first subject is measured up from the bottom trim line, one-half the vertical trim dimension. The vertical centerline is measured one-half the horizontal trim size of the subject plus trim allowance, if required. All other locations can be measured from the cylinder line and the vertical centerline of the layout. The location of the first subject is used as the reference dimension.

6-11. Registration

a. Introduction. Registration is the exact positioning of several printing images so that they will maintain their correct relationship to each other, either on one press plate, or on several plates printing on the same sheet of paper. Proper registration techniques are essential to the "step-and-repeat" methods of combination layout, and to multiple-color work, especially map reproduction (para 6-12 and 6-13).

b. Pin Register System (Punch and Stud Method).

(1) Of the many techniques which have been

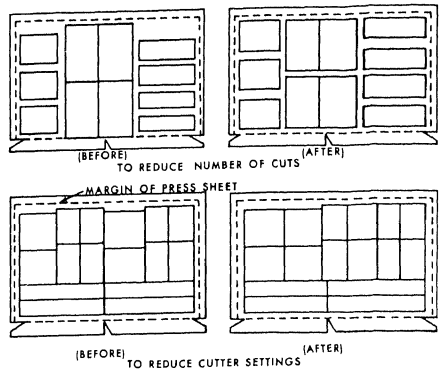


Figure 6-16. Layout changes to reduce cutting operations.

developed for registering flats to each other and to the press plates, the mechanical systems of punches and pins give consistently better results than the visual methods, which use various kinds of registration marks, such as butterfly marks cross-ticks (bombsights) and so forth.

(2) There is considerable variation in the printing industry in both the number and arrangement of holes and pins, but at least three points usually are used to insure the accurate positioning of all copy. Some systems place three pins along the bottom edge of the press plate; others use one side and two bottom points; still others place one pin on each side and one or two on the bottom edge.

(3) In one of the most frequently used systems, the desired number of holes are punched in the press plate, and in a master goldenrod or template, with the aid of a pin register board (fig. 6-3). Pins are fastened to the layout table to correspond exactly to the locations and relationship of these holes. By registering every flat to the master on the layout table, and affixing punched tabs to them corresponding to the pins on the table, correct positioning of each image is assured. Short buttons or pins (fig. 6-17) of the same diameter as the punched holes hold the different flats in perfect register with the litho plate during exposure. Physical contact between the flats helps to eliminate errors in registration.

c. Registration by Fitters and Dowels. This system is similar to the pin register method, but punching of holes is not required. Although the problems of maintaining a punch table and of keeping the punches sharp and adjusted are

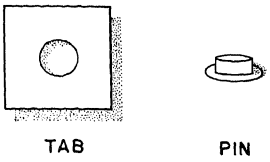


Figure 6–17. Hole tab and pin.

avoided, the results are less consistent, and this method should be considered expedient only.

(1) *Fitters and dowels.* The fitters are small, plastic, square or oblong tabs with pre-punched, ½-inch diameter circular holes. The holes may be elongated occasionally to allow for distortion in one direction. The dowels are ½-inch diameter rods which fit in the tab holes and are cut in length to fit various thicknesses of film. Some are made thicker to take more than one layer of film. One end of these dowels is backed with adhesive.

(2) *Placing the fitters.*

(*a*) Square or rectangular holes are cut in the negatives for one series of flats, and in the goldenrod masks. The holes must not interfere with the dowels and must permit the fitters to be attached.

(*b*) One set of plastic fitters is taped securely to the base negative. The dowels are passed through the holes in the attached fitters. The next negative of the series is carefully registered to the base. A set of fitters is slipped over the dowels coming up through the base negative and is securely taped to the top negative. Then the top negative and attached fitters are removed. All other negatives of this color are positioned and the fitters taped.

d. Registration Marks. If a punch table or fitters and dowels are not available, registration marks provide the platemaker with a visual means of registering secondary flats with the key flat. These marks are added outside the press sheet size by cutting the marks out of the flats or by stripping prepared marks into the flats. Butterfly cutouts and film register marks are used to register flats in multiple exposure layouts. The methods of applying these marks are as follows:

(1) Butterfly cutouts are cut through all flats simultaneously while the flats are in register. Simultaneous cutting insures that all butterflies are identical in size and shape and are in exact registration. A minimum of four butterfly cutouts per flat (two in the gripper edge and two in the tail edge of the flat) are required for accurate registration. These cutouts are established by the intersection of two cut lines and are completed by removing diagonally opposing triangular sections. During the press plate processing, the key flat is exposed on the plate first. The butterfly marks on the key flat are then used as guides to position the secondary flats. The accuracy of this system is primarily dependent upon the skill of the layout man and the number of times the flats are used. Butterflies are satisfactory where a positoning tolerance of 1/32 inch is acceptable.

(2) Film register marks, sometimes called bombsights (fig. 6–18), offer higher accuracy. These marks have two points of registration—the pin point at the center of the cross and the circle. Marks of this type are more difficult for the platemaker to use as the marks must be alined under a magnifier before exposing the secondary flat. These marks must first be stripped into at least three sides of the key flat and taped in position. The masking paper for the secondary flat is then alined over the key flat and taped in position. Cut openings in the secondary flat around the marks in the key flat. Position a register mark in each opening and aline with the register mark in the key flat. Tape the marks in position. Complete the secondary flat by registering the secondary negative and taping in position.

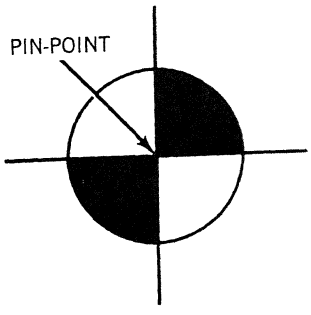


Figure 6–18. Film register mark.

e. Hinge Flap Methods. These methods can be used to combine negatives on one flat for multiple exposure (fig. 6-19). The use of "flap sections" makes it easier for the platemaker to register the negatives for exposure. This method does not permit the use of the maximum printing area of a press plate because one of the flap sections will cover a portion of the printing area during exposure of the other flap section.

(1) To prepare flap sections for only a portion of a flat, attach the first negative in position on the flat, turn the flat over, and cut out the exposure opening in the masking paper. Tape the second negative, emulsion side up, to a sheet of masking paper slightly larger than the exposure opening for the first negative. Cut an exposure opening in the masking paper. Register the second negative in position over the first negative and tape it down with a full length of pressure-sensitive tape along one edge of the mask. This tape strip will also serve as the hinge for the flap section. Swing the top flap away and cut through three sides of the lower flap section. Turn the flat over, emulsion side up. Make a border mask from masking paper and attach this mask to the flat so that it extends about ⅛ to ¼ inch inside the cut edges of the flap section opening. This mask will serve to cover the cut edges during exposure. If the marginal cuts of the flap sections do not come close to image detail on adjoining negatives, the flap sections can be trimmed slightly larger than the exposure opening. This eliminates the need for added masking strips. In use, the platemaker first tapes the flat in position on the press plate. The top flap section is then moved out of exposure position and secured with a small tab of tape. Masking is applied to the flat where needed and the first exposure is made. The flap section that was exposed is then moved out of exposure position and the second flap section is positioned for exposure. The remainder of the flat is then masked out and the second flap section is exposed by itself.

(2) To combine small negatives on one base for multiple exposure combination, the negatives to be combined are first registered to each other. The negatives are then trimmed so that each negative has one side that projects beyond the margin of the other negative. Place the two negatives on the masking paper, the size of which must fit within the contact frame. The two negatives are then registered to each other and taped in position on the masking paper. Each negative must be taped along its extended edge so that the negative will be attached to the masking paper and each strip of tape will serve as a hinge for one of the negatives. Cut an exposure opening in the masking paper to complete the layout.

(3) Large negatives can be attached to one base for multiple exposure combinations by taping the negatives along the same side. This method does not permit combination of images on a press plate, but can be used to make multiple exposure combinations on film. The negatives to be combined are positioned on a base, registered to each other, and taped in position along the same side. The sensitized film to be exposed is taped only along the opposite side to that used for the negatives so that it is also hinged to the base. The film is first interleaved between the first two negatives and the first exposure is made. For the second exposure, the first negative is moved away and the sensitized film positioned below the second negative, and so on until each negative has been exposed onto the film.

6-12. Multiple Color Layouts and Multiple Exposure Layouts

a. Introduction. Proper layout procedures are of critical importance in the production of printed material containing more than one color, or in the processing of a press plate from more than one flat. In each case, the registration of the several separate images to each other must be accurate and precise.

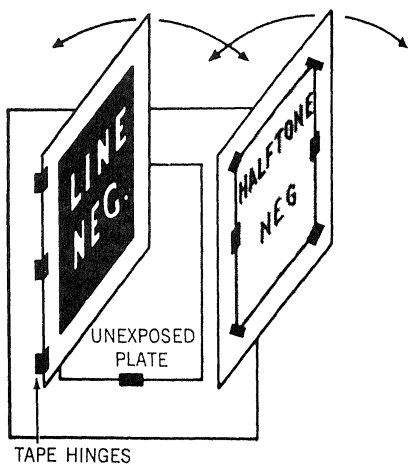


Figure 6-19. Flap section used to combine negatives.

b. Scope. The instructions and techniques dissed in this paragraph are directed primarily ward the production of maps, but may be effecrely applied to the printing of posters, leaflets, ook work signatures, and any other printed marial containing images which must be combined, the camera section, plate-making section, or on e press itself. Any of the various registration ethods discussed in paragraph 6–11 may be used, it emphasis is placed on the pin registration sysm. The various phases in the production of a ap which involve reproduction personnel, from e processing of the final compilation manuscript the preparation of the press plates, are graphiully illustrated in figure 6–20.

c. Layout Procedure for the Preparation of oated Plastics. In order to separate the various iap features on the compilation according to the olors in which they will print, the draftsman iust have a separate image of the compilation for ich of the desired colors. These images are procssed by the plate making section from a negative f the manuscript onto the required number of oated plastics (para 7–8), to be returned to the hotomapping section for engraving. The negative f the manuscript is prepared by the camera secon either by use of the copy camera, if the comilation is opaque, or is not the desired size, or by ontact, if the manuscript is prepared on a transarent base at the required scale for engraving. If contact negative is prepared, the manuscript itelf is laid up prior to making the negative; the ianuscript is placed on a flat and register holes re punched exactly as they will be positioned on he scribe-coated plastics, the plastic proofs, and he press plates. The press sheet outline must be hown on the manuscript. The layout procedure or either the negative or the manuscript is as ollows:

(1) A register bar (or register pins) is fasened to the layout table top at the nearest edge of he glass.

(2) The master template (para 6–3*q*) is olaced over the pins.

(3) The manuscript, or negative, is slid beieath the template and alined with the aid of the ress sheet outline. The edge of the manuscript nay require notching where the pins are located. When required, notches should be as small as posible. The manuscript is then taped to the glass op of the layout table, its position is rechecked, and the template is removed.

(4) Small pieces of scrap stable base film, prepunched with holes corresponding in shape to the pin register board punches are placed over the pins and securely taped to the manuscript. Care must be taken to insure that none of the manuscript image is covered, and that the holes, if oblong, are centered over the pins, and are alined in the same direction as the pin register board punches.

(5) The manuscript is removed from the pins, turned over, and the hole tabs securely fastened in place on the other side. This added taping insures that the tabs will remain in place. The manuscript is turned over again, base side up, and placed on the pins. The templet is placed over it for a final position check.

(6) If the flat is made with the original manuscript, the flat with the work order is sent to the camera section for contacting. The cameraman prepunches the sheet of film and uses register pins when exposing the negative. The negative must be returned to the layout section for necessary retouching before it is sent to the plate section for the processing of the coated plastics.

(7) If the flat was made from a negative of the manuscript, it is touched up as required in the layout section and sent to the plate section for processing.

(8) The platemaker prepunches the sensitized coated plastics to register with the manuscript flat and with each other. He then exposes each plastic to the manuscript, in the vacuum frame, using the pins or register bar to insure proper registration.

d. Preparing Flats for Proofing or Making of Press Plates. For each color of a multicolor map, there are at least two, and sometimes as many as eight separate negatives, each containing some of the map features or detail to print in that color. For example, there are usually four separate flats containing detail that will print in black: the culture, names, grid and marginal data (fig. 6–21). These must all be combined, in perfect register, during the platemaking phase, to make one black press plate. Similarly, all of the flats to print in each of the other colors are combined on one plate for that color. From 18 or 20 flats, five press plates are prepared, one for each color of a five-color map. It is essential, therefore, that all of the flats making up a set of reproducibles be perfectly registered, not only to other flats of the same color making up the same plate, but also to all the other flats making up the other plates to print on the same map sheet.

(1) The first step in preparing a set of flats for platemaking or proofing is to check the work

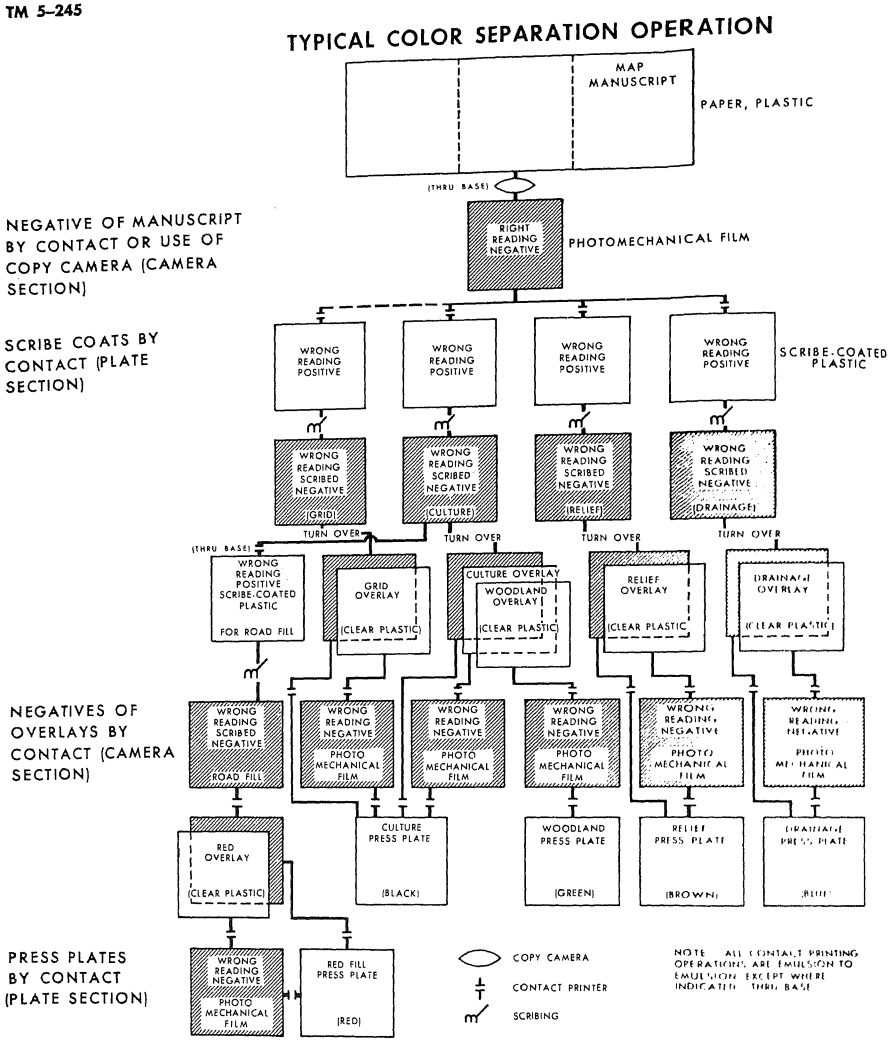


Figure 6-20. Color separation procedure.

order and the furnished negatives for completeness and clarity of instructions, and to insure that all necessary supplies and equipment are available.

(2) The negatives are sorted by printing color and examined for printing quality. Any necessary opaquing or correcting is completed at this stage.

(3) The layout table is equipped with a register bar or pins as described in paragraph 6–12*c*(1).

(4) Place the master template (para 6–3*q*) over the pins.

(5) Slide the marginal data negative (negative with the largest image area) under the template and position it relative to the two center lines and the press sheet outline. Use a sheet of tissue paper between the negative and template to clarify the template guide lines.

(6) Tape the negative to the light table with pressure-sensitive tape. Check its position with the template, and reposition if it shifted while being taped down.

(7) Remove the template and store in a drawer or other safe place. It will not be needed until the entire map has been laid up.

(8) Attach tabs, notching if required.

(9) Place the flat back on the pins, base side up.

(10) Lay the culture negative over the marginal data flat and carefully position it. Tape the culture negative to the table and attach the tabs.

(11) Recheck the register and correct if necessary.

(12) Lay the marginal data flat aside. It will be needed later to register legend features and strip in the unit imprint.

(13) Put the culture flat on the pins and register the next negative to it and attach the tabs. This culture flat will be used to register or position all the negatives with detail that must match culture features or the neatline, i.e. grid, road fill, built up areas, contour lines and wooded areas. Continue laying up all the negatives one at a time, cross referencing them to any other negatives they must fit.

(14) Register the drainage to the contour lines and cross-check against the culture.

(15) Register the open water negative to the drainage negative and cross-check against the culture and contour lines when applicable.

(16) Register the wooded areas and any other negatives to the culture and cross-check against the drainage. Be sure that vegetation open-windows are trimmed so that vegetation features are not printed in the roads or streams.

(17) Place the marginal data flat on the register pins and check the register of the legend symbols for each flat where applicable. It may be necessary to move the symbols.

(18) Strip in the unit imprint and if needed, the stock number. See the applicable TOPOCOM style sheet for location specifications.

(19) After the entire map is flatted and any stripping-in of material that is required has been completed, mask with goldenrod. A quick way to do this is described below.

(*a*) Punch as many sheets of goldenrod as required.

(*b*) Place several sheets on the register bar pins.

(*c*) Place the first negative, emulsion side up, on the pins and tape to the top sheet of goldenrod.

(*d*) Remove the flat from the pins and lay aside.

(*e*) Place the next negative onto the pins, tape to the goldenrod and remove. Continue this process until all the negatives have been masked.

(*f*) After all the flats have been masked, take them one by one, and cut out the mask covering the desired images. Pay particular attention to small symbols outside the neatline that print in the legend. Many press kiss plates are needlessly run because a careless layout man did not open a legend symbol.

(20) Opaque as required.

(21) Identify each flat with the following information:

(*a*) Printing color.

(*b*) Number of the flat, and the total number of flats of that color (e.g. 1 of 4, 2 of 4, etc.)

(*c*) Map sheet number.

(*d*) Work order number.

(*e*) Screen number, when required.

e. Older Reproducibles. Sometimes the reproducibles available for reprints were prepared before the introduction of the pin register system. When this is the case, such material should be converted to the pin register system. The equipment and techniques used in laying up new manuscripts are used in the same way to convert older reproducibles to the pin register system.

6–13. Step-and-Repeat Layouts

Step-and-repeat is a form of combination layout in which a negative or group of negatives is posi-

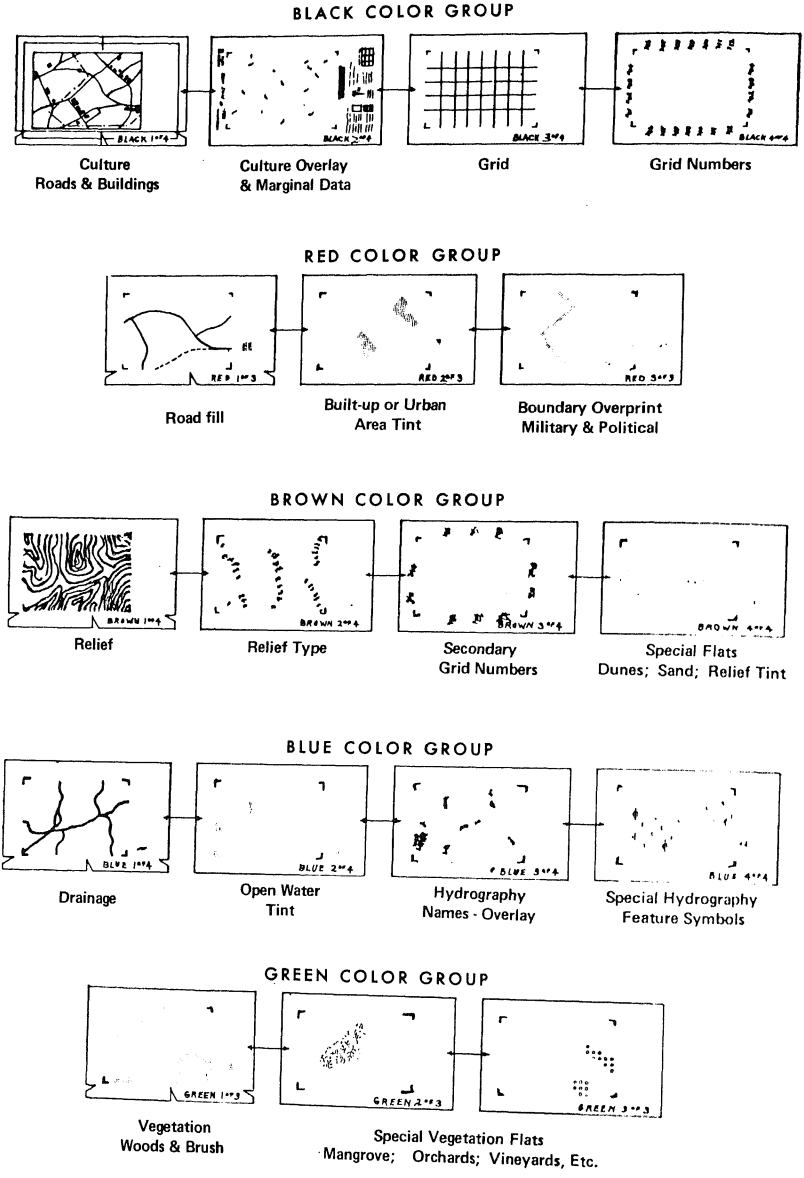


Figure 6–21. Combination of map features.

tioned on a flat and then exposed in successive positions by "stepping" the flat across the press plate. The terms "step-up" and "step-over" indicate the direction in which the flat is stepped on the pressplate between each exposure. Before preparing a step-and-repeat layout, the grouping of the subjects and the step-and-repeat method to be used must be determined. The method depends on job requirements and on the size of the vacuum frame to be used. Vacuum frame size must be considered to assure that the flat is within the sealing edges of the vacuum frame during each exposure. Once the method is determined, the layout procedure is the same as for a combination flat. The basic reference lines are drawn first. Positioning lines for locating the negatives on the flat are then drawn as detailed in paragraph 6–12*b*. The positions for the register marks, hole tabs or butterfly cutouts for the step movements are added to complete the flat. Several types of layouts for step-and-repeat use can be prepared, each type based on the direction in which the flat is stepped during exposure. The main types of step-and-repeat layouts are as follows:

a. Horizontal Steps. For simple two, three, or four exposures across the pressplate, the flat may be positioned by using register holes, register marks, or butterfly cutouts located along the gripper and tail edges (fig. 6–22). To prevent the flat extending out of the vacuum frame during exposure, or having to fold the flat for the end exposures, locate the register holes, marks or cutouts to one side of the subject rather than centered on the subject. The stepping marks are applied to the flat outside of the press sheet area and spaced the exact distance required for each step (fig. 6–23). In use, the flat is positioned on the pressplate, masking is adjusted, and the first exposure is made. If register marks or butterfly cutouts are used, these marks are locally developed and used to position the flat for subsequent exposures. If register holes are used, pressure-sensitive adhesive dowels are inserted through the holes. The flat is then shifted to the second exposure position, masking is adjusted, and the second exposure is made. These steps are repeated until the remaining exposures are completed.

b. Horizontal Steps (Alternate). Another method for stepping a flat with a single set of register marks or register holes, is to use two strips of film or paper on which the step locations are marked. Dowels can be attached and used instead of marks. The location strips are attached to the gripper and tail edges of the plate. In use, the flat is moved from one location on the strips to the next as each exposure is made. The masking is changed with each step.

c. Two-Step Expose and Twist Flat. Prepare the flat to cover half the pressplate. Locate the register marks or holes on the vertical centerline of the press sheet about which the flat is to be rotated,

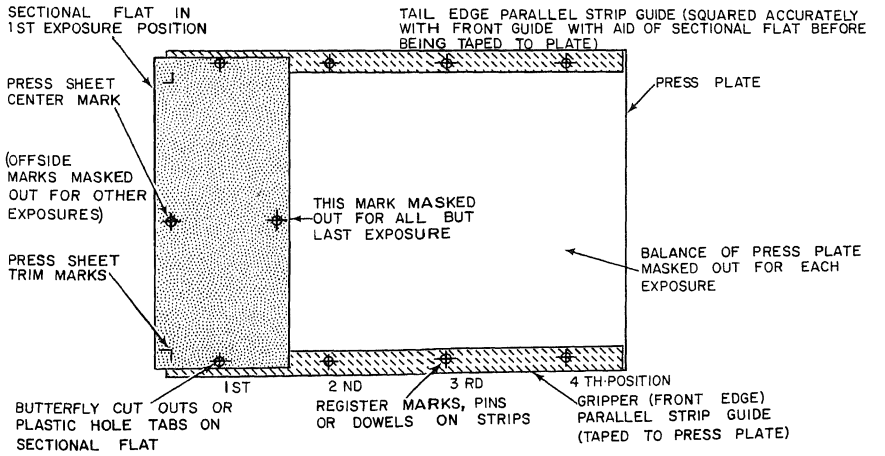


Figure 6–22. Parallel strip step-and-repeat guide.

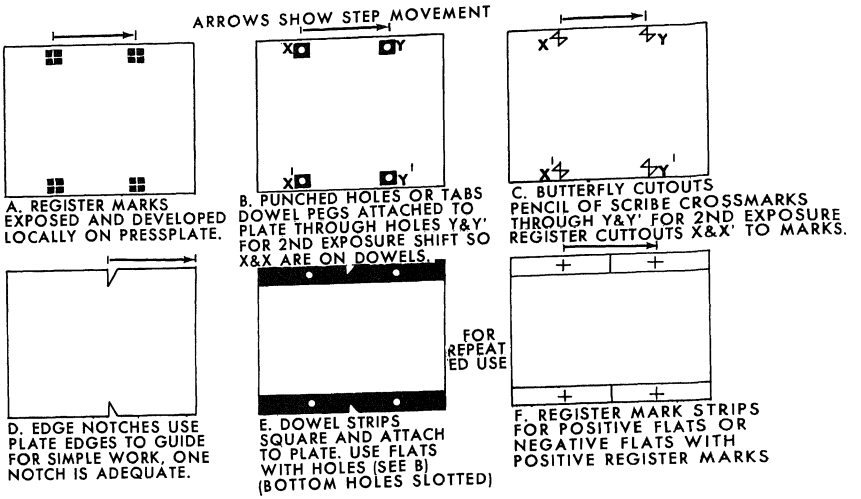


Figure 6–23. Register systems.

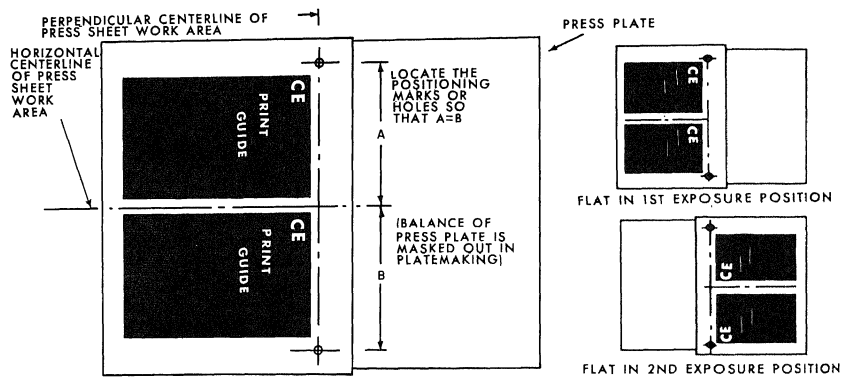
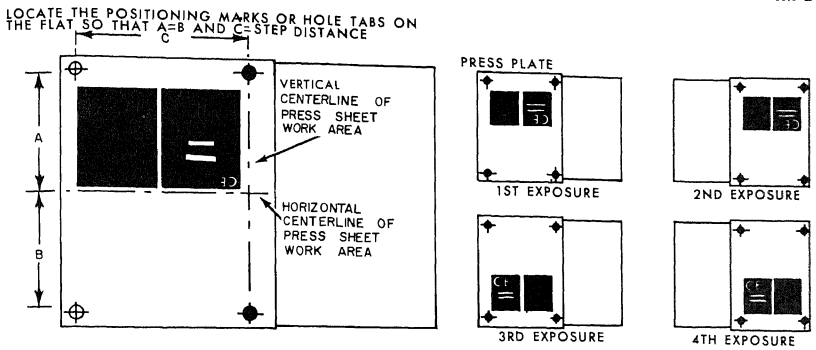


Figure 6–24. Two-step expose and twist flat.

and at equal distances from the horizontal centerline of the press sheet. The single set of register marks or register holes is used to position the flat during exposure. In use, the flat is positioned heads-up for the first exposure, and heads-down for the second exposure (fig. 6–24).

d. Four-Step Expose, Twist and Shift Flat (Step and Swing). This layout positions the film so that it will occupy two alternate locations on the pressplate. The alternate positions of the film are positioned to register marks or holes. In use, the flat is first exposed on one corner of the plate, then shifted to the adjacent corner and exposed. The flat is then twisted and positioned to expose the remaining two corners; the protective mask is shifted and the exposures made (fig. 6–25).



THE TWO POSITIONING MARKS OR DOWELS ARE PLACED ON THE VERTICAL CENTER LINE OF THE PRESS PLATE AND USED TO POSITION THE FLAT FOR EACH OF THE FOUR EXPOSURES.

Figure 6–25. Four-step, expose, twist, and shift flat.

e. Four-Step Heads Alike. If all subject heads must be in the same direction on the press sheet, several layout arrangements are possible. Six register marks or holes can be used if there is sufficient clearance between the work area and the trim margin of each subject. If the subject detail comes close to the trim margins, then seven register marks or holes must be used.

f. Exposure Templet. A templet can be used to provide the locations of step-and-repeat exposures on the pressplate. The templet may be used to expose register marks; as a guide for scribing marks; or to position register dowels on the pressplate. The templet can also be used as a base to position and hold the negatives in the successive exposure positions.

(1) To use a templet to expose register marks, a layout is drawn on a sheet of masking paper or plastic material to indicate the position of the register marks or register dowels on the pressplate. These locations should, if possible, be centered on the trim line or be midway between trim lines to reduce the number of marks or dowels required. The templet is used to expose register marks (or to attach register dowels) on the pressplate which are used to position the negative for each exposure of a step-and-repeat flat. If many location marks are required, it is advisable to prepare a templet that will expose small register mark locations on the pressplate. The pressplate is exposed and developed to make the register marks visible. This provides a pressplate with register marks to which the negative can be successively positioned.

(2) If the templet is to be used as a negative carrier, it is made from a transparent acetate, vinyl, or polyester sheet. As the negative will be mounted in successive locations on the plastic sheet, the layout is laterally reversed from normal flat layouts. Each of the successive positions that the negative will occupy can be scribed lightly into the film or drawn as light blue positioning lines on the plastic sheet. Plastic dowels can also be used if they do not interfere with adjoining exposure detail. To use the templet as a negative carrier, the templet is keyed to the pressplate using punch holes (or hole tabs) and dowels. Gripper notch lines or register marks can also be used, but are less efficient and less accurate. In use, the templet is positioned on the pressplate. The negative is registered to the templet and taped in position (fig. 6–27). The balance of the templet is then masked out and the first exposure made. The negative is shifted and the masking adjusted for each additional exposure.

6–14. Signature Layouts

a. Signature layouts for bookwork are combination layouts that consist of a number of different pages so positioned that the pages will print, fold and bind correctly to become part of a book or other publication. Signature layouts require special considerations and procedures based on a thorough understanding of all the finishing operations, including the possible use of slitters, the order of folds, the type of binding, and the required margins.

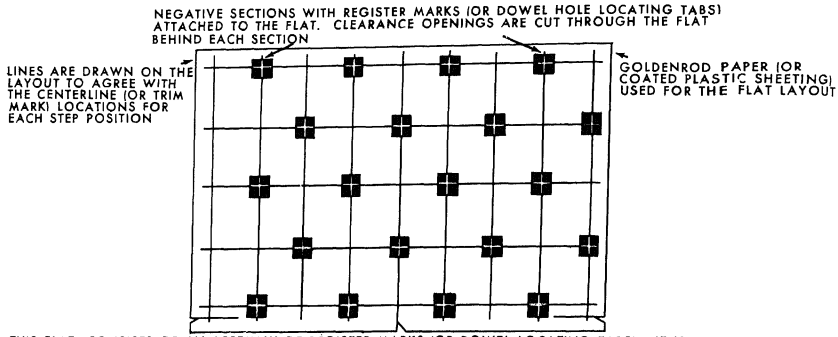


Figure 6-26. Step-and-repeat exposure templet.

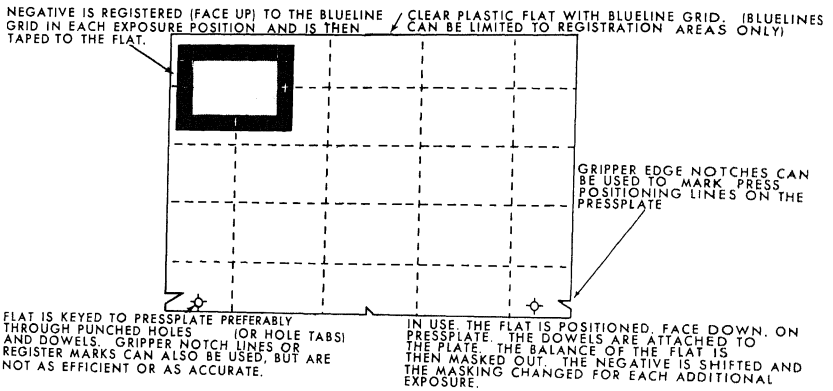


Figure 6-27. Templet used as a negative carrier.

b. Signature layouts for bookwork have specialized terms which are peculiar to the field. The meaning of these terms must be known to fully understand the subject. The following definitions are the most essential.

(1) *Dummy*—A blank paper mockup of the book, folder, or other work to be printed that shows the proposed size, shape, layout, and grade of paper to be used for the job.

(2) *Page*—A page is one side of a leaf of a book with specific margins on all sides (fig. 6-28).

(3) *Margin*—That part of a page outside the main body of printed matter.

(4) *Folio*—The page number. Unless otherwise noted, odd-numbered folios are right-hand pages.

(5) *Flyleaf*—A blank leaf at the beginning or end of a book.

(6) *Frontispiece*—An illustration fronting the first page or title page.

(7) *Imposition*—Positioning and assembling negatives or positives into printing location on a flat. Sometimes used to describe similar operations when preparing a flat.

(8) *Signature*—A printed sheet (or its flat) that consists of a number of pages so arranged that they can be folded and bound together as a section of a book.

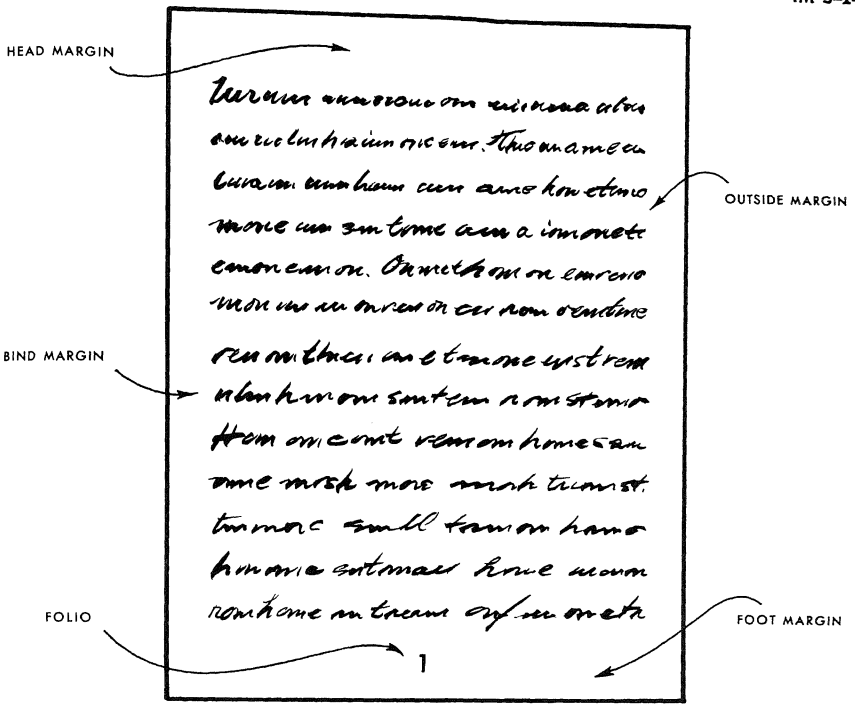


Figure 6–28. Book page.

(9) *Saddle stitch*—A method of binding in which signatures are collated, and then stitched from the outside fold through the center of the folded back. Wire staples or thread are used for the stitching (fig. 6–29).

(10) *Side or flat stitch*—A method of binding in which folded signatures or cut sheets are stitched along and through the side (fig. 6–29).

(11) *Case bound*—A method of binding for thick publications, known also as Smyth sewing, which permits the publication to open flat. It consists of two or more signatures which are saddle stitched with thread and at the same time sewn to each other. A backbone is glued in postion and a hard cover or case is added. Side-stitching may also be used, but the publication will not open as flat (fig. 6–29).

c. A dummy should be prepared before attempting the layout of signatures for bookwork. The dummy provides a guide for the positioning of each page on the flat and also insures that all pages are correctly backed and in proper sequence. To prepare a dummy, first fold a sheet of blank paper to produce the desired number of pages. For a new arrangement of signatures, it is advisable to run a sheet of paper through the folding machine to obtain the correct folds. Based on the folded sheet, the margins and trim allowances are indicated on the dummy. The page numbers (folios) are then marked at the bottom of each page. Indicate the top of each page by the letter H (head) and use the letter X to show the bind or fold edges (fig. 6–30). To complete the dummy, label the cover to indicate the job for which the dummy was prepared. From the folded dummy the distance between pages can be determined and used to prepare the layout. The position of each page is determined in relation to the basic refer-

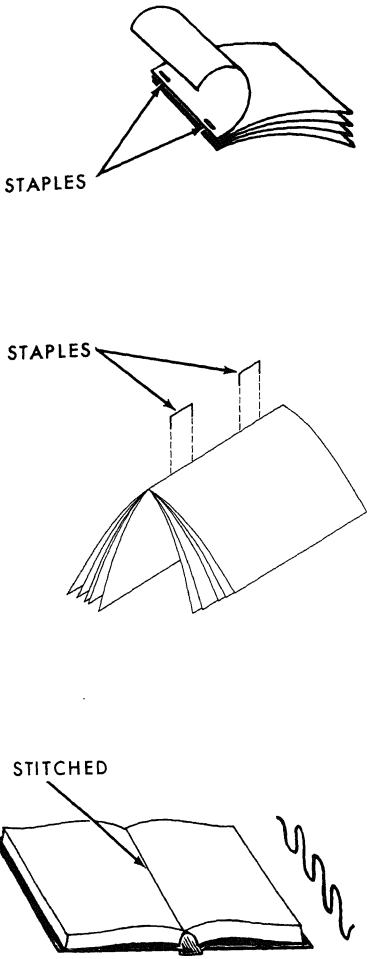


Figure 6-29. Binding methods.

ence lines and indicated on the layout. Pages are usually arranged with the lowest numbered page positioned along the gripper edge. This helps identify the gripper edge and establishes uniform layouts. Remember that the layout is laterally reversed when the negatives are positioned emulsion side up, and the dummy must be similarly reversed to transfer all markings correctly to the corresponding pages. If the markings are copied in reverse on the emulsion side, the layout will be a readable replica of the dummy when it is completed and turned over. Several types of signature layouts are used in bookwork. The most common impositions for signature layouts are:

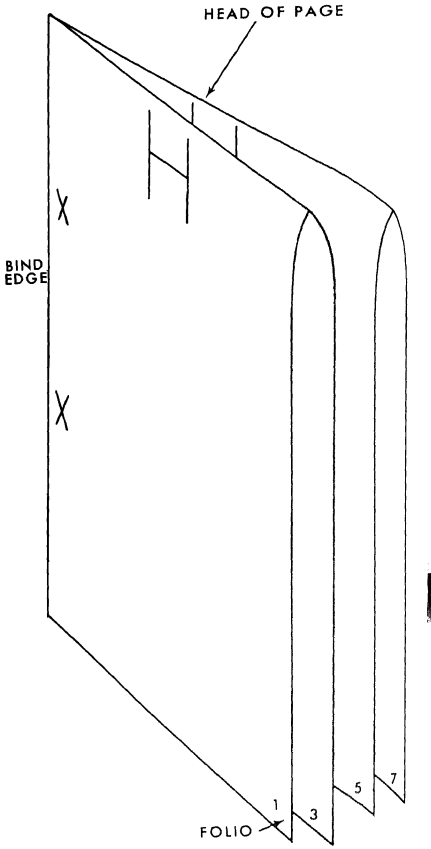


Figure 6-30. Layout dummy.

(1) *Work-and-back (sheetwise) layouts.* A work-and-back layout provides for separate press-plates to print the front and back of a signature (fig. 6-31). When one side of the press sheet has been printed, the sheets are laterally reversed and the backup printed using a second pressplate. The

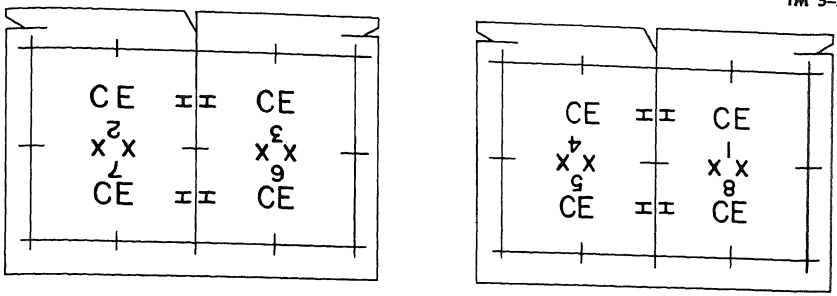


Figure 6–31. Sheetwise layout.

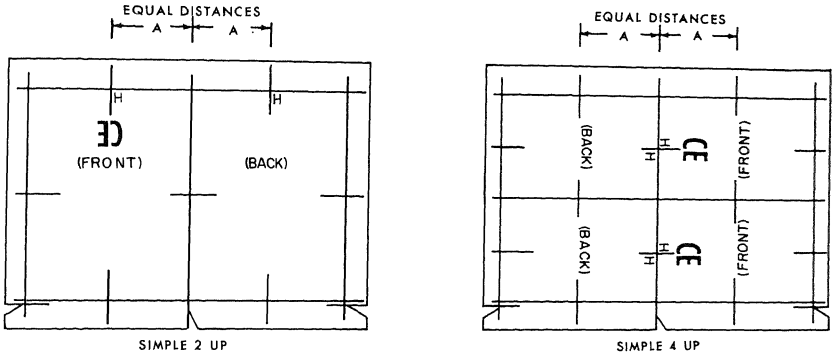


Figure 6–32. Work-and-turn layout.

same gripper edge of the press sheet is used for the second press run. The arrangement of a work-and-back layout is determined from a dummy and positioned on the layout in relation to basic reference lines.

(2) *Work-and-turn layouts.* These layouts are used to print two or more complete signatures on one press sheet. On a work-and-turn layout, the front and back pages are positioned on the same flat, so arranged that when one side of the press sheet is printed and the press sheet is then laterally reversed, the reverse side of both front and back pages can be printed using the same press-plate. The same gripper edge and same side of the press sheet is used for positioning during both press runs. By using the same gripper edge, register difficulties due to slight variations of press sheet dimensions are avoided. For work-and-turn layouts, the following requirements must be considered:

(*a*) The vertical centerline on the layout must be at right angles to the gripper line. Any deviation will be doubled when printing the back of the sheet.

(*b*) The pages on one-half of the layout must be located in exact symmetry with those of the other half to assure that the pages back each other correctly. If the pages are positioned with sides along the gripper edge, a head-to-head or foot-to-foot arrangement must be used. Pages are positioned on the layout in relation to basic reference lines and arranged as determined from a dummy (fig. 6–32). Wherever possible, work-and-turn layouts should be prepared on a precision layout table to obtain accurate alinement between back and front pages.

(3) *Work-and-tumble layouts.* Work-and-tumble layouts use the opposite edges in printing both sides of the sheet. The press sheets are

turned over from top to bottom when the backup is printed. Since this results in two different gripper edges, the paper stock must be trimmed accurately on all four sides to assure good register. Work-and-tumble layouts are satisfactory where exact backing of printed pages is not essential, as differences in sheet size in the paper stack may cause such backing to vary. The advantage of work-and-tumble layouts over work-and-turn layouts is that the same front and side guide positions are used which keeps press adjustments to a minimum. The principal requirements for work-and-tumble layouts are as follows:

(*a*) The layout must be based on both the horizontal and vertical centerlines of the press sheet. The horizontal centerline is used instead of the cylinder line as a basic reference line to position the pages on the layout.

(*b*) The head of each page must be positioned to back correctly. For pages parallel to the gripper edge, the head direction of those on the top half of the layout will be opposite to those on the bottom half. For pages perpendicular to the gripper edge, all heads can be in the same direction (fig. 6–33).

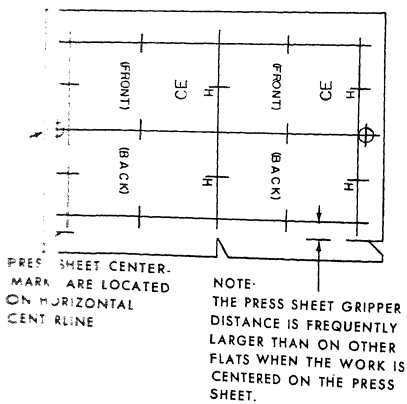
d. Signature Imposition. The type of folding machine used, the sequence of folds, and the method of binding determine the page arrangement selected for a signature. Figure 6–34 shows examples of signature layouts for work-and-turn and sheetwise arrangements.

6–15. Care of Layouts After Platemaking

Layout flats represent an investment of labor and material which includes the cost of copy preparation, photography, and stripping operations. After they have been used for platemaking, they may be stored for future reuse, forwarded to another agency, or destroyed. While some flats are outdated immediately after the job is printed, others may be reused with or without changes. Final disposition is usually specified in the job instructions or unit operating instructions.

a. Storage of Flats. Practically all flats are stored for varying periods of time following their use in platemaking. Flats are best stored in numbered and indexed folders, each containing from 10 to 25 flats. Slipsheets of clean paper should be used between flats to prevent their sticking to each other. They should not be rolled or stacked as this can lead to damage. The folders should be stored on shallow shelves or metal drawers in steel cabinets, preferably in a fireproof room which is temperature and humidity controlled.

b. Inspection of Flats for Reuse. Before an existing flat is reused, it is necessary to inspect it for any changes or damage which may have occurred during storage. Changes and replacements, in the form of new copy and new negatives, are usually furnished for stripping. These must also be checked before using. A routine check system should be used to insure that no important details are overlooked. This system should include a check on the following:



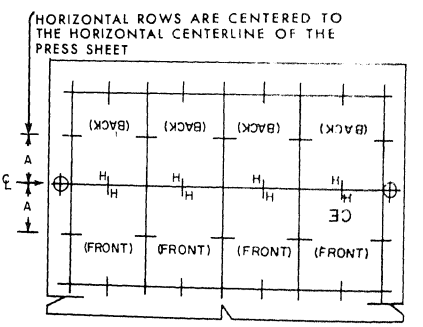


Figure 6–33. Work-and-tumble layout (simple and head-to-head).

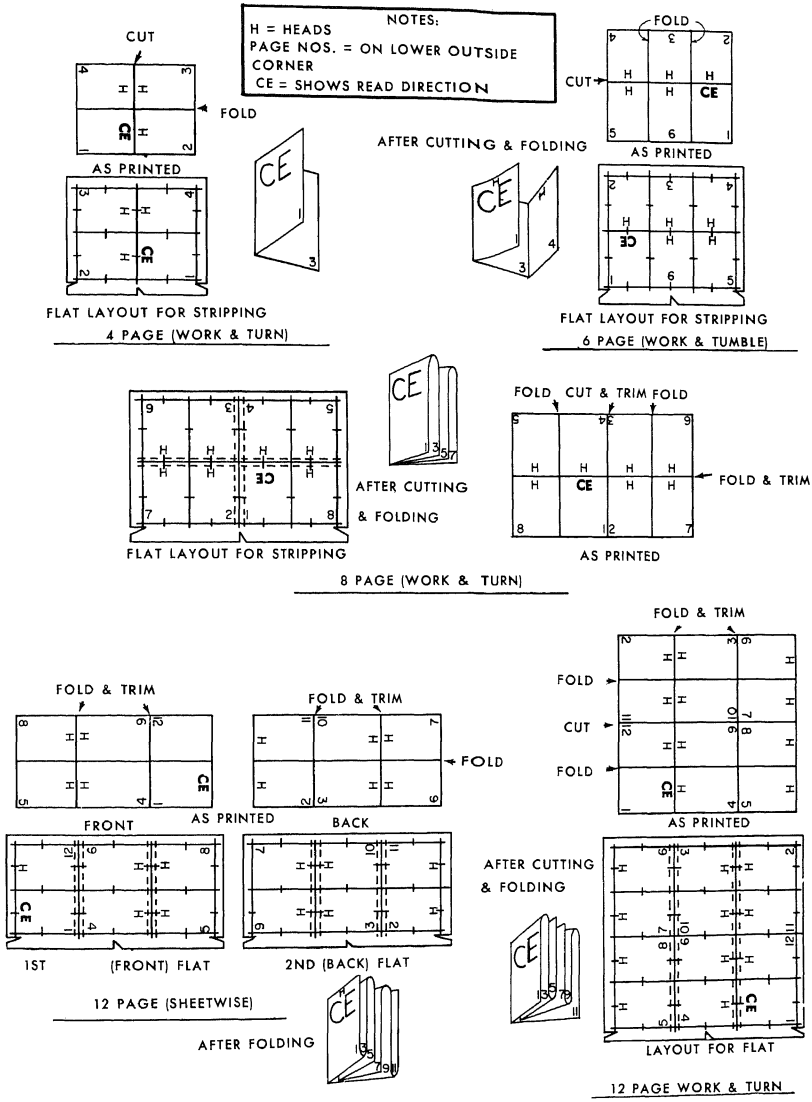
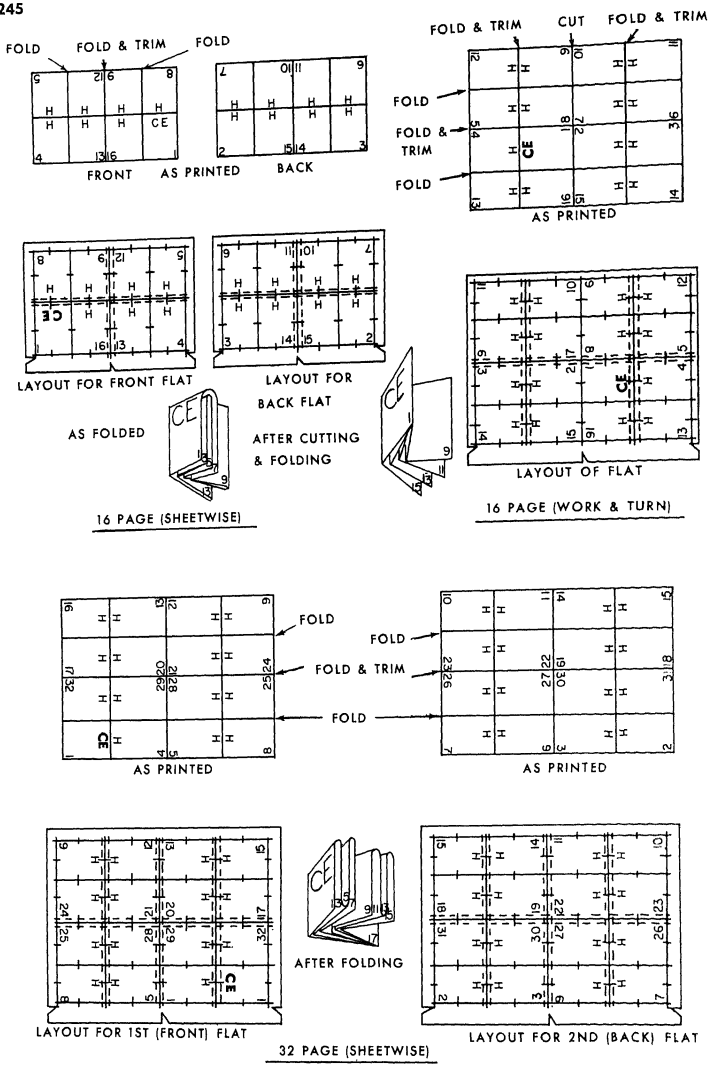


Figure 6-34. Signature layouts.



NOTE: ORDER OF FOLDS AND PAGE ARRANGEMENT WILL VARY WITH EQUIPMENT AND PAPER STOCK

Figure 6-34—Continued.

(1) *Damage* Inspect for damaged or missing films, torn flats, discolored or stained films due to residual chemicals, unfastened films, wrinkled films or flats, and discolored clear tape over image areas. Films that are seriously damaged, or that have deteriorated in storage, should be replaced.

(2) *Dimensions.* Check all dimensions, as most films shrink to some extent over a period of years. Creeping or other distortions also occur. The overall dimensions may vary between seasons of the year due to differences in temperature and humidity.

(3) *Dated matter.* Items that are dated, such as unit imprints, must be checked to determine if changes are necessary to bring these items up to date.

c. Changes in Flats. When new film sections are to be stripped into a flat, it is important that they match the other films. The new film must be identical in weight of text characters and line detail, film density, fog level, dot size, and other properties to blend inconspicuously with the older films. When changes in text matter are required, it is advisable to reset the entire paragraph or body of text, since copies made at different times seldom match each other. Unmatched films can show noticeable changes in weight of text characters or overall appearance. These changes may be due to the difference in processing conditions, or in text preparation. The procedure for replacing a section of a film is the same as for stripping-in inserts, as detailed in paragraph 6–7 above.

d. Transmittal of Flats. Completed flats should be transmitted in folders or other containers to prevent damage in transit or in handling. Folders made of draft paper or similar type materials are suitable for safe transmittal and temporary storage of flats. *Flats should never be rolled or folded!* This may cause the pressure-sensitive tape to creep or break loose and result in a displacement of the films on the flat.

6–16. Layout Defects and Corrections

a. Layout Defects. Difficulties in preparing layouts usually result from size changes caused by humidity variations. Changes in moisture content may also be caused by resting the arms on the layout sheet, and from the warmth of the lights within the layout table, particularly where incandescent lamps are used. Moisture variations within the sheet can produce waves or bulges that alter any dimensions drawn on its surface. It is easier to avoid such difficulties than to remedy them. Masking paper should be stored in the layout section so that the paper is acclimated to the conditions in the work area. When spotting out negatives on a flat, avoid resting the arms on its surface. Use an arm board or a sheet of dry blotting paper, if a support is needed. Differential shrinkage is another difficulty that may be encountered when working on flats. This distortion can occur between the films and the base material, between masks and the films, between different thicknesses of films, or between any of these and the pressure-sensitive tape. Since the expansion coefficients of paper and film are different, humidity variations cause different size changes in the films and in the goldenrod flat or other base material to which they are attached. This results either in waves in the base material or in bulged or wrinkled films. Errors in location and lack of good contact during platemaking can result. Humidity control within the work areas is the best prevention for such conditions. Where the distortion is particularly bad, it may be necessary to expand or contract the film by changing its moisture content. The film can be expanded by placing it between two sheets of slightly dampened blotting paper. If the film is slightly larger than specified, it can be reduced by lowering its moisture content. This can be done by placing the film on a warm layout table or in a drying cabinet. When the film has been changed to the correct size, the press plate must be immediately exposed to it.

b. Negative Defects. Difficulties with negatives may be—

(1) *Photographic.* Defects can be caused by dust or scratches on the camera glass, halftone screen or film, focusing errors, and vibration in the camera. Processing defects can be due to air bubbles in the developer, static and friction marks, and fogging owing to chemicals or to age of the films. Fogging can also result from light flare or overexposure. Minor specks and flaws on negatives can be retouched or opaqued out. Negatives with major defects, such as fogging, lack of density, or damaged halftone, must be remade.

(2) *Dimensional.* Acetate films shrink slightly in processing and they also shrink or stretch from humidity variations. Such variations are more pronounced in the thin base films than in the heavier base films. Processing shrinkage usually continues for several hours after the films have dried, and where accurate alinement or register is important, the films must be allowed to stabilize before they are used for layouts. Where humidity control is lacking, all films used on a flat

should be of the same base material and thickness to insure uniform dimensional changes.

(3) *Emulsion properties.* Water-soluble opaques do not adhere to a negative surface that is greasy. If this condition exists, the surface can be cleaned with clean cotton or tissue dampened in a volatile solvent. Opaques that adhere to a greasy surface, such as turpentine or acetate opaques, can also be used. Excessive hardening of a negative during processing, or excessive drying or aging in storage, can make the emulsion brittle. A brittle emulsion cannot be engraved or scraped easily and may form fine cracks if flexed excessively. Before engraving lines on any negative, test the emulsion along the margin outside of the image area. If the emulsion chips away to produce a ragged line, the cause may be either a dull engraver or a brittle emulsion. Examination of the engraved line under a magnifier will indicate which is at fault. The engraver is dull if the emulsion is furrowed and raised along the ragged edge of the engraved line. If the emulsion surface is not raised, but the edge of the line is chipped away in an irregular shape, the emulsion is too hard. A hardened emulsion can be engraved by using a sharp point and light, repeated strokes which remove only a portion of the emulsion with each stroke. The emulsion can also be conditioned for engraving by soaking it in a solution of glycerin in water, as described in paragraph 6-6.

(4) *Stains.* Stains may be due to an exhausted developer, insufficient washing, smeared opaque, oil, or similar materials. If the stains are due to processing, the film should be returned to the camera section for clearing. Water spots can be removed by resoaking the negative in water containing a small proportion of a wetting agent. After soaking for a few minutes, wipe the film lightly with a cellulose sponge. Dust or rust specks imbedded in the gelatin can be similarly removed by first soaking the film and then brushing it lightly with a camel's-hair brush under running water to avoid scratching the emulsion.

(5) *Scratches.* Scratches through the emulsion should be repaired only when the time required to retouch them is less than the time required to make a new negative. For scratches in areas of fine detail, the dampened emulsion should be flattened with a smooth burnishing bone, or polished plastic or glass rod. Opaque can be applied after the emulsion has dried. Dirt or opaque imbedded in a scratch in the exposure areas of the negative can be scraped away by using light strokes. Where the scratch has shaved away the emulsion, softening the emulsion will not help to flatten the surface or close the gap. Such instances must be corrected by retouching with opaque.

c. Damage to Flats. Flats are usually damaged by careless handling which results in tears or creases. If the goldenrod mask is torn, the flat should be returned to the layout table and checked for alinement. The torn edges can be taped together with red or black pressure-sensitive tape. A tear through the image area of a line film can be repaired by attaching a strip of clear pressure-sensitive tape on the back side. It is usually more practical, however, to have a replacement made for negatives which have numerous tears or creases. If a halftone negative has been torn and a new one cannot be made from the original copy, the damaged negative should be removed from the flat and a contact positive made. The halftone positive is corrected by touching up the dots with a fine etching needle. A duplicate negative is then made from the corrected positive. Similar methods are used to correct torn positives. If films are creased, but not broken through the image area, do not crease in the opposite direction to straighten. Instead, flatten the crease by carefully pressing down on its surface with a steel triangle. Add tape to hold it in this position. A crease will similarly flatten out under vacuum pressure during platemaking.

CHAPTER 7
PLATEMAKING AND COLOR PROOFING

7-1. Mission of Platemaking Section

a. The principal mission of the platemaking section of a lithographic printing plant is to make press plates suitable for use on an offset lithographic press from the negative flats prepared in the layout section.

b. A secondary function in topographic units, where most multicolor printing is done, is to prepare composite color proofs on plastic of the reproduction negatives for multicolor maps. These color proof sheets are used to check the accuracy and registration of the color separation negatives before the litho plates are made.

c. Another function of the platemaking section of a topographic unit is to place the negative images of map compilations on the required number of coated plastic sheets, to be scribed and color-separated by the photomapping section. Upon completion of the scribing, these are returned to the platemaking section, first, for color proofing, then for preparation of the press plates. For an alternate method of color separation, the platemaking section processes positive blue-line images of the compilation on paper.

7-2. Equipment

The essential equipment for the operations of the platemaking section are: a carbon arc lamp; a vacuum frame, including the pump and motor; a work table; a supply of plates (commercially prepared, presensitized aluminum plates with a diazo-type coating, or uncoated grained aluminum); processing chemicals (these vary with the type of plates); a large work sink; cellulose sponges; cotton swabs; plate clamps; cheesecloth; and a supply of water. Additional supplies needed for color proofing work are plastic sheets and special dye solutions. A plate whirler was used formerly for applying these solutions, but has been largely replaced by manual application methods known as rub-on, or wipe-on. Also needed is a Baumé hydrometer, to measure the specific gravity of liquid solutions.

a. Vacuum Frame.

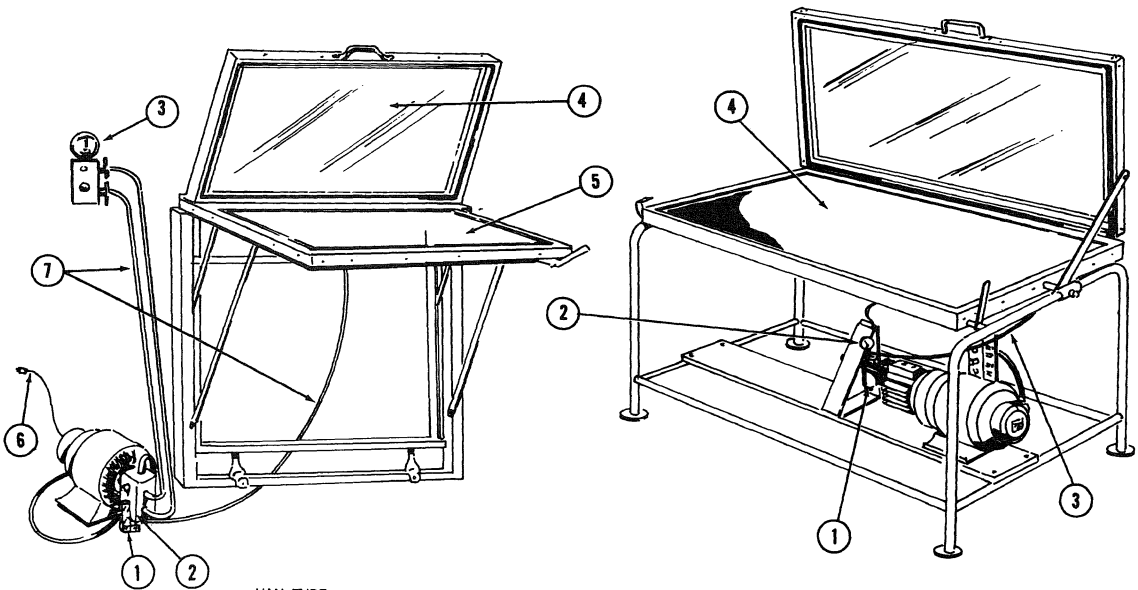
(1) *Description.* The vacuum printing frame holds the flat and the light-sensitive plate closely together durng exposure. Good contact is required to prevent light from undercutting the opaque areas of the negative and spreading or thickening the printing detail. The vacuum frame (fig 7-1) consists of two metal frames, supported on a stand and hinged so they can be separated or brought together. The two frames can be rotated on a swivel from horizontal to vertical. The upper frame carries a plate of thick, clear glass, and the lower has a rubber blanket bordered by a rubber sealing ring. The blanket contains a fitting connected by a rubber hose to the vacuum pump. The pump has adjustments for the amount of vacuum and a gage to register the "pull."

(2) *Operation.* The sensitized pressplate is placed on the rubber blanket of the lower frame, and the flat is positioned over it. The two frames are locked together. The vacuum pump is turned on to remove the air between the frames, and to bring the plate and flat into good contact. The frames are tilted into the vertical position for exposure. Following exposure, the frame is rotated into the horizontal position, the vacuum released, and the frame opened to remove the flat and the plate.

(3) *Pressure.* The maximum suction obtainable with the vacuum frame is approximately 30 inches of mercury (dial reading), corresponding to about 15 pounds per square inch (psi). In normal operation, a vacuum of about 23 is used. It provides adequate contact without taxing the vacuum pump.

b. Arc Lamp. For description, see paragraph 5-8.

(1) *Purpose.* The arc lamp (fig 7-2) is used in conjunction with the vacuum frame to expose the light-sensitive plate coating through the image areas of the flat. Carbon arcs provide the intense actinic light to act upon the sensitive emulsion on the plate and convert it into a compound which is insoluble in water.



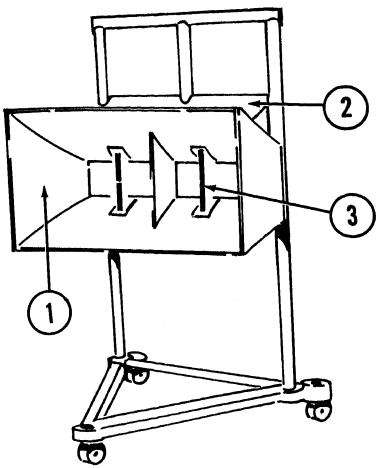
VAN TYPE

1. AIR FILTER
2. AIR MUFFLER
3. VACUUM GAUGE
4. GLASS
5. BLANKET
6. ELECTRIC CORDS
7. HOSES

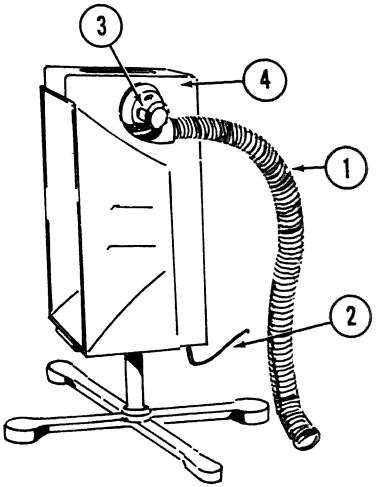
INSTALLATION TYPE

1. AIR MUFFLER
2. VACUUM GAUGE
3. HOSE
4. RUBBER BLANKET

Figure 7–1. Vacuum frame.



STANDARD PORTABLE
1. REFLECTOR
2. SOLENOID COVER
3. CARBON RODS



PORTABLE WITH EXHAUST
1. EXHAUST SYSTEM
2. ELECTRIC CORD
3. FAN
4. SOLENOID COVER

Figure 7–2. Arc lamp.

(2) *Operation.*

(*a*) Insert the carbons into their holders and adjust so that there are approximately 1½ inches of free play between the tips when the carbons are separated manually.

(*b*) Place the arc lamp parallel to the vacuum frame. The distance between the arc lamp and the frame must be slightly greater than the diagonal length of the plate being processed. The arc lamp distance is measured from the point where the carbons meet to the center of the cover glass on the frame.

(*c*) Turn on the arc lamp and expose.

c. Density of Liquids and Baumé Hydrometer.

(1) *Specific gravity.* The density of a substane is its weight per unit of volume and the specific gravity is a ratio which tells how much heavier (or lighter) a substance is than water. The specific gravity of a substance is the same whether English or metric system units are used. Lithographers are mainly concerned with liquid solutions and the Baumé hydrometer is their measuring device.

(2) *Hydrometers.* The hydrometer is a graduated tube with a given amount of lead weight at the bottom. Placed in a liquid, it sinks until it has displaced an amount of liquid weighing as much as the hydrometer itself. The depth to which it sinks is a measure of the specific gravity of the liquid. It sinks deeper into liquids of low specific gravity than it does into liquids of high specific gravity.

(3) *Baumé hydrometer.* The Baumé hydrometer is graduated so that 0° Baumé is the reading for water (that is, it is a reading indicating a specific gravity of 1), and readings above 0° Baumé correspond to specific gravities higher than 1. However, a Baumé reading of 6.5° does not mean that the specific gravity of the substance being measured is 6.5—this reading actually cor-

responds to a specilc gravity of about 1.1. The difference between the specific gravity of the various solutions used in platemaking are so minute that the third digit after the decimal is significant. This makes the use of specific gravity readings inconvenient. For example, a liquid would have to be described as having a specific gravity of "1.083 to 1.086" instead of simply "Baumé 5.0° to 5.6°". Therefore, this hydrometer is prepared on the Baumé scale.

(4) *Procedure.* To determine the Baumé of a solution, first fill a container with the solution to be measured, and place the hydrometer in the liquid with the weighted end down. Do this carefully so that the hydrometer is not broken. Push it down into the solution and then allow it to reach its own height. Read the Baumé value of the solution at the point where the surface of the liquid touches the shaft of the hydrometer. To get an accurate reading, the solution being measured must be free of air bubbles and undissolved particles. If there is foam or froth on the top of the liquid, it must be removed so that the surface of the liquid across the hydrometer can be observed accurately. Since temperature affects the specific gravity of a liquid, the Baumé readings should be taken at 77°F. If all solutions are mixed under the same conditions and the temperature changes, there is no need to make adjustments. The Baumé changes about 0.1° for each 5.5°F. As the temperature goes up, the Baumé goes down.

d. pH of Solutions.

(1) *pH scale.* Just as the Baumé is important in maintaining solutions at a constant specific gravity (density), the pH value is important in maintaining the activity strength of the solutions. The activity strength (acidity or alkalinity) is measured on a scale numbered from 0 to 14, each number being a different pH value. A solution which is neither acid nor alkaline has a pH value of 7.0, this being the midpoint of the scale. Values from pH 7.0 to pH 0.0 indicate acid solutions, the strength of which increases as the pH value decreases. For example, an acid with pH 5.5 is weaker in activity strength than the acid with pH 1.5. Similarly, alkaline solutions are indicated by values above pH 7.0, and these increase in strength as the pH value increases. For example, an alkaline solution of pH 13.5 is far stronger than one with pH 8.5. There are some materials, not commonly considered to be acid or alkaline, which, when mixed with water, register a pH value of either acid or alkali. When dissolved in water, alum acts as an acid to give a pH reading below 7.0, while sodium bicarbonate reacts as a alkali to give a pH reading above 7.0.

(2) *Importance of pH values in platemaking.* If each platemaking solution is mixed at a constant pH value, each finished plate will react more uniformly to the various treatments given it by the pressman.

(3) *Recommended pH values for solutions.* It is recommended that the coating solution be maintained at a pH value of 7.6, but any pH between 7.0 and 8.0 is satisfactory. The coating will have a value of approximately 5.6 before ammonium hydroxide is added. The following pH values are recommended for the solutions used in platemaking:

Ammonium bichromate stock solution	pH 4.5–6.2 (5.5)
Ammonium hydroxide stock solution	pH 10.0–11.0
Gum arabic solution	pH 4.4
Plate etch	pH 2.0

Methods for measuring the pH values of solutions are presented in full in chapter 8. The acidity of the fountain solution (pH value) is discussed in paragraph 8–20.

7–3. Safety Procedures

a. Chemicals. Chemicals of any kind are a hazard when improperly handled. The procedures for safe handling of chemicals outlined in paragraph 5–4 for darkroom operations apply equally to platemaking. Some of the more critical safety practices are—

(1) Never pour water into acid; always pour the acid slowly into the water.

(2) Never smell an open bottle; smell the cap, if such identification is necessary.

(3) Wash hands often when handling chemicals.

(4) Keep containers closed and working area well ventilated.

(5) Do not mix unknown chemicals together. Dispose of unneeded and unidentified chemicals.

(6) Label all containers.

(7) Use safety glasses, gloves and apron when working with strong acids and alkalis.

b. Equipment. Carelessness in handling and operating platemaking equipment can cause injury to personnel or damage to the equipment.

(1) Close and raise the lid of the vacuum frame carefully. Do not open the lid latch when the vacuum is on. Avoid touching the closing latch when the frame is in the vertical position, as the glass could spring open and shatter.

(2) Never look directly into lighted carbon arc lamps. Always call a warning before turning

on the lamps: close the curtain, call "LIGHTS" and pause before turning them on. Always press the OFF switch before adjusting carbon rods. Never handle hot carbon rods.

(3) Carry plates by the gripper and tail edges (fig. 7–3). Secure all plates to the work table with plate clamps before processing (fig. 7–4 and 7–5). Handle lithographic plates carefully to avoid cuts.

(4) Keep floors clean and dry.

Figure 7–3. Proper way to carry an aluminum plate.

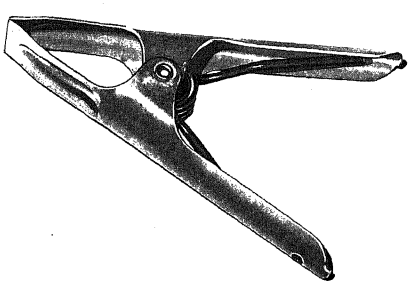


Figure 7–4. Hand clamp.

7–4. Presensitized Plates

a. Introduction. Presensitized plates are the most widely used type of plate in military printing plants. They are as simple, quick and easy to use as a sheet of film, and thus have largely replaced conventional zinc plates, which had to be grained with special equipment and sensitized by a slow and complicated process. Presensitized plates are factory-coated, and can be exposed as they come from the package, without prior processing. Although a number of commercial organizations manufacture presensitized plates, their basic characteristics are similar. Slight variations in the method of processing generally are explained in the manufacturer's information sheet which accompanies each package.

b. Characteristics of Presensitized Plates.

(1) *Grainless aluminum.* Most presensitized plates are made of thin sheets of grainless aluminum. Because they have no grain, these plates retain fine negative detail very well. The thickness of the metal depends on the size of the plate, the larger plates being thicker than those used on smaller presses.

(2) *Light-sensitive coating.* The plates are machine-coated by the manufacturer with an ex-

Figure 7–5. How to use hand clamp when processing a lithographic plate.

tremely thin diazo coating. Because the diazo materials used react with metal, the plates are first treated with a sodium- or phosphate-silicate type of coating, which inhibits the action of the diazo on the aluminum, and which leaves it very water-receptive. Some presensitized plates are coated on only one side, but usually they are coated on both sides, and can be used to make two separate plates.

(3) *Sensitivity to light.* No darkroom is required to process these plates, and they are not affected by small amounts of ordinary light, before or after exposure. Strong or prolonged light, however, may damage them. Since they are insensitive to yellow light, it is preferable to handle them under yellow bulbs, or regular light bulbs shielded with goldenrod paper.

(4) *Shelf life.* Presensitized plates have a normal shelf life of 6 months to 1 year. Expiration dates are stamped on each package. If stored under proper conditions, however, their shelf life may be extended beyond the normal expiration date.

(5) *Storage.* Unprocessed plates should be stored in a cool, dry place. Since they are affected by excessive heat or humidity, and by ammonia fumes, they should not be kept near radiators, doors or windows that are frequently open, or near open bottles of ammonia. They should always be stored flat, to avoid denting or warping the thin metal.

(6) *Appearance.* After processing, the image area is visible, highly ink receptive, and very water repellent. The nonimage or background area is a semidull, natural aluminum color, which is water receptive and ink repellent.

c. Processing Presensitized Plates. Most presensitized plates are processed by a four-step method consisting of exposure, desensitizing, developing, and gumming. A simpler two-step procedure is used for some types of plates, consisting of exposure and development with a chemical which combines desensitizing, developing and gumming into one step. Following is a description of the procedure in a typical four-step plate-processing operation.

(1) *Preparation.*

(*a*) Obtain a package of presensitized plates of the proper size.

(*b*) Prepare the work table by covering the work area with clean paper.

(*c*) Assemble the necessary materials: desensitizer-gum solution (process gum); developing lacquer; spring clamps; cellulose sponges (or cotton swabs); and cheesecloth.

(*d*) Check and clean the cover glasss on the vacuum frame.

(*e*) Take a plate from the package, using care to grasp the edge farthest from you and lift it toward you, without sliding it over the other plates in the package.

(2) *Exposure.*

(*a*) Center the plate, light-sensitive side up, on the rubber blanket of the frame.

(*b*) Register the flat over the plate with the emulsion side in contact with the plate. See paragraph 7–6 for registration methods. If the flat is an "open window" negative, requiring screening of a pattern symbol, such as swamp, or a dot tone, such as open water, place the appropriate screen between the negative and the plate.

(*c*) Close the vacuum frame and turn on the vacuum pump motor. Wait for complete contact between plate and flat. Pressure will vary between 20 and 30 pounds, depending on the vacuum frame being used.

(*d*) Move the frame into the vertical position for exposure.

(*e*) Position the arc lamp about 36 inches from the frame.

(*f*) Turn on the lamp and expose the plate according to the exposure established by the sensitivity guide ((6) below). This will be approximately 45 seconds with a double arc lamp or 1½ minutes if using a single arc. The exposure must be sufficient to harden the sensitized coating completely in the printing area. Over-exposure will have no ill effects provided that perfect plate-to-negative contact is maintained and that the negative has sufficient density in opaque areas. Under-exposure, however, may result in a broken image or no image at all, and may also shorten the press life of an apparently satisfactory plate. The 21-step sensitivity guide ((6) below) should be used as an aid to good exposure.

(*g*) Turn off the lamp and the vacuum pump motor.

(*h*) Raise vacuum frame to horizontal position.

(*i*) Open the frame.

(3) *Desensitizing.*

(*a*) Remove the flat and carry the plate to the work table.

(*b*) Place the hand clamps shown in figures 7–4 and 7–5 to hold the plate firmly on the work table.

(*c*) Pour a small amount of the desensitizer

gum on the plate to form a pool 4 to 5 inches in diameter.

(*d*) Using a clean cellulose sponge (or cotton swab), cover the entire plate with the desensitizer gum.

(4) *Developing.*

(*a*) While the plate is still wet with desensitizer gum, add image developer or developing lacquer on the plate. The amount will vary with the size of the image area.

(*b*) As soon as the developer is added, spread it uniformly over the entire area of the plate. Continue rubbing until a uniform development is obtained. Additional gum may be added if the plate becomes too dry.

(*c*) Wash off the excess developing lacquer.

(5) *Gumming.* Spread another small amount of desensitizer gum over the plate with a cellulose sponge. With a loosely wadded ball of clean cheesecloth, smooth the solution evenly over the plate.

(6) *Sensitivity guide.* A good method of determining correct exposure time is by the use of a 21-step sensitivity guide. To use this guide, fasten it to the plate or mount it in the goldenrod mask somewhere outside the press sheet outline, as shown in figure 7–6. After the plate has been exposed and developed, wash off the excess developer and vigorously rub the image which has come up through the sensitivity guide. If the plate is underexposed, the developed image is loosely bonded to the plate and will rub off quickly. When exposed adequately, it will remain firmly bonded in the area of steps 6 to 8.

(7) Because most commercially-produced plates are coated on both sides with the diazo coating, it is sometimes convenient to expose both sides of the plate before development. Besides saving time in setting up the exposure, the two sides can be desensitized and then developed in one continuous operation, and no harm is done if any of the chemicals should seep under the plate. If only one side of the plate is processed, the platemaker must be careful to protect the unexposed side of the plate from the processing chemicals.

7–5. Diazo Wipe-On Plates

a. General. In addition to presensitized plates, military printing plants also use diazo wipe-on

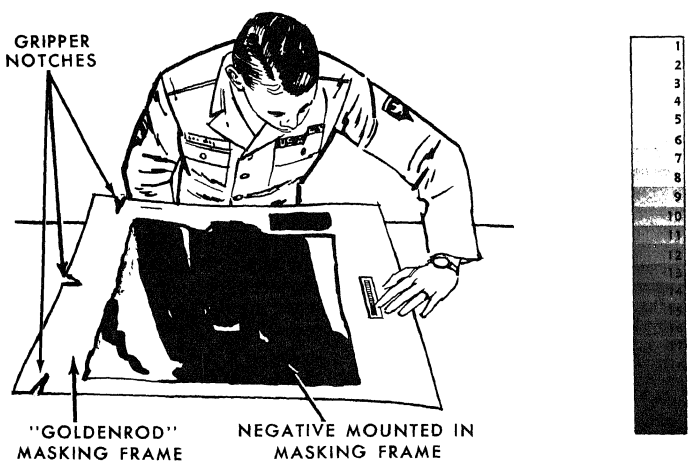


Figure 7–6. 21-step sensitivity guide.

plates. Like the presensitized plates, these are made of aluminum treated with a silicate coating to prevent oxidation and to prepare the surface for the light-sensitive coating solution. The major difference between these plates and the presensitized plates is the hand application of the sensitive diazo coating by the platemaker. Wipe-on plates have a fine grained surface. Until the diazo coating is applied, these plates have an indefinite shelf life, and provide an excellent backup system, especially for field units, for whom supplies of presensitized plates may not always be available. Once the coating has been applied, however, they should be used as soon as possible, because the coating deteriorates fairly rapidly.

b. Wipe-On Coating. The coating is a commercially prepared diazo compound, supplied in dry form, with a separate container of solvent. Packaged thus, the coating has a far greater shelf life than diazo materials in liquid form. The coating material usually is applied to the plate by wiping or rubbing with a lint-free wipe material, in a manner similar to gumming an exposed plate. Some very large shops use special roll-on equipment to apply the coating to the plates, but in most field units, with less space and a smaller volume of production, the wipe-on method is used.

c. Required Materials and Equipment.

(1) Work table (to accommodate the pressplate and containers of processing solution). The table should be covered with clean paper larger than the pressplate. This paper should be changed each time a platemaking step is completed.

(2) Arc lamp.

(3) Vacuum frame.

(4) A large sink.

(5) Paper pads if available, (closely woven, lint free).

(6) Cheesecloth pads (folded to approx 3 x 5 in. size).

(7) Plate clamps.

(8) Cellulose sponges.

(9) Aluminum plates pretreated with silicate coating.

(10) Commercially prepared diazo coating solution with powdered diazo sensitizer.

(11) Image developer.

(12) Gum arabic solution (2° Baumé).

d. Preparing Coating. Mix the powder with the liquid according to the manufacturer's directions. Shake the mixture vigorously until all the tiny particles are dissolved. When possible, let the mixed solution stand overnight under refrigeration.

e. Applying Coating. Work in subdued or yellow light when applying the light-sensitive coating. Place a pretreated plate on the work table on top of a *clean* sheet of paper larger than the plate. Clamp the paper and plate to the edge of the table with the hand clamps. Pour ¼ ounce of the coating mixture in the center of the plate surface and spread it with a paper pad. Coat the plate across the grain (left to right) first, then with the grain (top to bottom). Discard the paper pad if it has been exposed to light, becomes contaminated, or dries out. Fan the coating dry for approximately 1 minute.

f. Exposing Plate. Expose in a vacuum frame in contact with the negative with the arc lamp placed at a distance of 4 feet. Exposure time will vary from 2 to 6 minutes, depending on the thickness of the coating and the age of the solutions.

g. Developing Plate. Remove the plate from the vacuum frame and clamp it on top of the work table. Be sure that the table is covered with clean paper larger than the pressplate. Using a paper pad, wipe the image developer over the entire plate to develop it for not less than 1 minute. When developing, use adequate pressure to insure that the lithographic image is a dark color of relatively high opacity. Wipe off the excess developer with a clean cheesecloth pad. Place the plate in the sink and wash off remaining excess developer. Apply a thin coating of gum arabic solution (2° Baumé) and dry. The plate is now ready for the press.

7-6. Registration

a. Simple Layout. Registration for a one-flat, one-color layout is a relatively simple matter of alining the gripper edge of the layout flat with the gripper edge of the plate. The procedure generally is as follows:

(1) Center the plate, light-sensitive surface up, on the rubber blanket of the vacuum frame.

(2) Use a rule to locate the center of either of the two long sides of the plate. This side is designated the gripper edge. At the center of the gripper edge scribe, or mark with a sharp pencil, a short line perpendicular to the edge.

(3) Place the flat over the plate with the negative emulsion side in contact with the plate. Aline the *perpendicular side* of the gripper notch with the line just scribed, and the gripper edge of the flat with the plate gripper edge.

(4) Close the vacuum frame and move it into position for exposure.

b. Multiple "Burn". Frequently, a number of separate negatives must be exposed on the same plate to print in the same color. This is generally true in topographic work, where the color separations may include scribed, film, and peel-cote negatives, all printing in the same color, and four or five exposures may be necessary to make one plate. In other lithographic work, separate halftone and line drawings may be combined on the same plate, or the same or separate negatives may be exposed successively by step-and-repeat or other combination methods (sec III, ch 6). These are called "multiple burns" and require very precise registration techniques. The pin register method provides reliable and accurate positioning of more than one negative on the same plate, and insures accurate registration of several plates printing in different colors on the same paper. The method generally is applied as follows:

(1) Use the pin register board to punch holes in the plate or plates, to correspond to the punched holes or the attached hole tabs on the flats (para 6-11).

(2) Place a pin in each of the holes in the plate. A small piece of tape across the pin head will prevent it from slipping out while the plate is being handled.

(3) Position the plate at the center of the vacuum frame. Place the first flat over the plate, emulsion side down, aligning the holes in the flat over the pins in the plate.

(4) Close the frame and turn on the vacuum pump. After the vacuum pressure has been built up and before exposure, visually check to be sure that the negative flat has not slipped from the pins. (This can result in a registration error.)

(5) Use the normal procedure for making the exposure.

(6) Open the frame and remove the flat.

(7) Place the second flat, for the particular color being copied, over the pins and repeat (4), (5), and (6) above.

(8) Continue this procedure until all of the flats of that color have been exposed onto the plate.

(9) Develop the plate in the normal manner.

(10) The preceding steps are repeated for each color to be printed.

7-7. Color Proofs (Rub-On Method).

a. General. Before the press plates are made for the final reproduction of a map, the color-separated drawings are carefully edited to insure that all detail is complete and correctly symbolized, and that there are no overprints or mis-registration of colors. The edit is usually made on a composite color proof, prepared by the reproduction unit. Each of the negative flats is exposed, in sequence, onto a sheet of white plastic, sensitized for each exposure with the appropriate color coating.

(1) If the flats containing the black printing detail are to be exposed first, the plastic sheet is given a light-sensitive coating containing a black dye. The black flat or flats are exposed and developed. The black lines or areas remain on the plastic sheet and the remainder of the sheet is washed clean.

(2) The plastic sheet is then recoated with a light-sensitive emulsion containing dye of the next color to be exposed. This color flat is registered and exposed. The second exposed coating is developed.

(3) This process is repeated for each remaining color and the end result is a proof sheet with all detail in the correct map colors. The map editors or any other interested persons use this proof to check the map content *before* the lithographic plates are made. Corrections are made on the negatives before printing.

b. Equipment and Materials. The following materials and items of equipment are used in the color-proofing process:

(1) Vacuum frame and arc lamp.

(2) Cloth pads.

(3) Bleached cheesecloth.

(4) SL 100 lacquer.

(5) Proof-cote clear base solution.

(6) Coating solutions in all required colors.

(7) Running water.

(8) Ammonium hydroxide.

(9) Pumice powder.

(10) White polyvinyl chloride sheets (24" x 30").

(11) Registration studs or dowels.

c. Procedure. Color proofs are made on opaque white polyvinyl chloride sheets that are relatively free from surface defects. To prepare a color proof, the plastic sheet must first be punched to match the set of registered reproduction negatives to be proved, and coated with lacquers to prepare the surface. It is then sensitized with a color coating, registered to the flat or flats to print in that color, exposed and developed. The lacquers which prepare the surface of the plastic are applied only once; the sensitive color coatings, exposure, and

development are repeated for each color to be printed.

(1) *Preparing the surface of the plastic.* Clean the surface of the plastic of any dirt or grease with a soft pad, pumice, and water. Pour a small pool of SL 100 lacquer on the plastic and spread evenly over the surface with a cloth pad or cheesecloth ball. While the lacquer is still wet, rub it evenly over the surface with a dry cheesecloth ball until the first dry streaks appear, then stop rubbing. A fan may be used to speed the drying. When the SL 100 is completely dried, pour a small pool of the clear base solution in the center of the plastic, spread evenly with pad or cheesecloth, and while it is still wet, wash the excess coating off in the sink with a fine spray of water. Dry the plastic completely.

(2) *Applying the sensitive coating.* A pool of approximately 1½ ounces of coating solution is poured in the center of the sheet. The coating is spread evenly over the surface with a cheesecloth ball and rubbed down. No pressure is required to rub the coating down smoothly other than the weight of the cheesecloth ball itself. When the first dry streak appears, rubbing is stopped, and an electric fan is used to complete the drying. When the coating is dry, the sheet is ready for the first exposure.

(3) *Exposing the plastic to the flat.* The coated base material is placed in a vacuum contact printing frame. Studs are inserted into the punched holes, and the first negative is positioned emulsion side to the coated side of the base material by fitting the punched holes over the projecting studs. The printing frame is closed, air evacuated, and the exposure made. A carbon arc supplies the light source and exposure time is dependent upon two factors: first, the distance between the arc lamp and the vacuum frame, and second, the amperage of the lamp. Additional negatives of the same color are substituted for the original, one at a time, and exposed. After the last exposure, turn off the vacuum, open the printing frame, and remove the negative and studs from the base material.

(4) *Developing the color image.* Place the exposed sheet in a large sink (coated side up). Wash the coated side with a weak ammonia solution (1 ounce of ammonium hydroxide to 1 gallon of water.) Spray tap water on the plastic to wash the coating away from the unexposed areas. If coated areas are difficult to remove, a second application of ammonia solution, swabbed lightly with an absorbent cotton ball, easily removes the undesired coating. Repeat the procedure completely for each succeeding color.

(5) *Sequence of colors.* No definite sequence is required for application of colors. Good results usually are obtained, however, by exposing the darker colors first, then the medium colors, and lastly, the light colors.

d. Color Proofing Solutions. The sensitive color coatings used in the color-proofing process are bichromated caseins with varying amounts of pigments added. They are commercially prepared, but are available to authorized topographic units through TOPOCOM.

7–8. Preparing Negative Images on Coated Plastic for Scribing

a. General. Most map compilation manuscripts contain all of the basic topographic linework on one copy, sometimes in appropriate colors, sometimes in monochrome film form. To print a multicolor lithograph of such a compilation, features to print in various colors must be put on separate negatives, to permit the making of a different press plate for each color to be shown on the final map. At one time, these color-separated copies were inked as positive images on metal-mounted paper which contained a "blueline" image of the compilation (para 7–9). Film negatives of these drafted bluelines were used to make the press plates. Scribing or engraving the desired detail on flexible coated plastic has almost completely replaced ink drafting for color separation of map manuscripts. The term "blueline image" may still be used in some shops to refer to these plastics, but the image placed on the plastics may be any color which contrasts well with the coating, and is more often black than blue.

b. Color-Separation Process. A master negative is made from the compilation manuscript by the camera section. The platemaker uses this negative to place the image, also in reverse, or wrong-reading, on the coated plastic sheets. Usually, one plastic is made for each color to be printed on the final map (fig. 6–19). The set of plastics containing the image of the compilation is sent to the photomapping section where each color is separated by the scribing process. The negative engraver, using various scribing tools, cuts away the coating from the image of the desired features on each plastic, leaving the image of all other features uncut. This produces a negative, on which only those lines which have been scribed will permit the passage

of light. The completed engraved negatives are used to make the various press plates, without the intervening camera step necessary for inked blueline color separations. TM 5–240 describes the color-separation process in detail.

c. Coated Plastics. The coated plastic scribing material is commercially produced and is available through normal supply channels. One side of the film has an orange or rust-colored translucent coating with a dull silken finish, on which the negative image is placed. The platemaker sensitizes the coating, exposes it to the master negative of the compilation, and then develops the image.

(1) The plastic base material is dimensionally stable, to maintain accurate scale and registration; transparent, to permit sharp reproduction of detail; light and reasonably flexible, for easy handling; and tough and durable, for future revision work or printing. Vinylite, dyrite, and mylar meet these specifications for scribing plastics and are commonly used by military topographic units for color separation.

(2) The coating serves as the medium upon which the compilation image is printed, and although it is visually translucent, it is actinically opaque, that is, it prevents the passage of light. It is tough, yet flexible, and soft enough to permit easy scribing. It must adhere tightly to the base material, so that sharp angles and closely parallel lines may be cleanly scribed.

d. Chemical Solutions. The following chemical solutions are needed for the various steps of sensitizing and fixing negative images on plastic:

(1) *Blueline sensitizer.*

Solution A	Potassium ferricyanide	2 oz
	Water	12 oz
Solution B	Ferric ammonium critrate	4 oz
	Water	12 oz
Solution C	Egg albumin flakes	16 oz
	Water	60 oz
	bring to a baumé of 3°.	

Mix equal parts of A, B, and C and strain through cheesecloth before using.

(2) *Blueline fixer.*

Phosphoric acid	6 oz
Water	1 gal
or	
Nitric acid	1 oz
Water	2½ qt

(3) *Censitizers for other colors.* The stock solutions for sensitizing color proofs (para 7–7) may also be used for sensitizing coated plastics when it is desirable to apply an image in a color othr than blue.

(4) *Reclaiming solution.*

Ammonium hydroxide	3 oz
Water	1 gal

e. Procedure for Applying Black Rub-On Coating.

(1) Place a sheet of scribe-coated plastic, coated side up, on clean paper on a work table and clamp to prevent slipping.

(2) Pour a pool of approximately 1½ ounces of blackline sensitizer solution in the center of the sheet. Spread the sensitizer evenly over the surface of the sheet, using a lint-free pad to coat the plastic surface. Wipe with a cheesecloth ball, with long, sweeping strokes from top to bottom and from left to right. No pressure is required other than the weight of the cheesecloth. When the coating begins to show dry streaks, stop rubbing and complete the drying with the aid of an electric fan.

(3) Place the completely dried sheet, coated side up, in a vacuum frame, place the master negative to be exposed over the plastic with the image wrong-reading and expose with the carbon arc lamp. The image is processed in reverse on the scribecotes so that after engraving, they may be used as final reproduction negatives. Punch and stud methods of registration are used to insure that the image is in the same relative position on each plastic of the set.

(4) After exposure, place the sheet of material, coated side up, in a large sink. Flush the exposed side profusely with tap water using a spray attachment on a hose. Pour a weak ammonia solution (1.0 oz ammonium hydroxide to 1.0 gal water) over the sheet and allow it to stand for a few seconds. Spray the sheet again with water. Clean out the nonprinting areas with a cellulose sponge until all unexposed coating is removed. Be careful not to use too much pressure, since this will remove the colored image. Then blot the sheet on newsprint or other clean paper.

(5) When the plastic sheet is thoroughly dry, make an image adhesion test to determine whether the image adheres to the base material. To make the test, stick a 2-inch strip of pressure-sensitive tape to the image and remove it with a quick pull. If any part of the image adheres to the tape, the image is unsatisfactory for production work.

f. Procedure for Applying Blueline Rub-On Coating. The procedure followed in applying a true blueline coating to scribe-coated plastic is abo

the same as when applying the black coating. The sensitizing solution and the fixer are different, however (*d*(1) and (2) above). Pour the blueline sensitizing solution onto the center of the sheet of scribe-coated plastic and spread it evenly over the sheet with a pad, then smooth with a ball of cheesecloth. Expose it in the vacuum frame in the same manner as described in the preceding section. Remove the plastic sheet from the vacuum printing frame and place it in a tray containing the acid fixer solution. This solution "sets" (stains) the image and intensifies it. Darker images are easier to see on the coated plastic, and will not affect the plate, since light will only pass through the engraved lines. Bathe the plastic sheet in the acid fixer. The plastic should "set" in about 30 seconds. Then remove it and wash it thoroughly under running water until all acid has been removed. Be careful not to touch the image until after it has dried because it will smear or pull away from the plastic base.

g. Reclaiming of Coated Plastic Material. If the blueline image produced is imperfect or unsatisfactory, the sheet may be reclaimed before it dries by placing it in a tray containing the reclaiming solution (*d*(4) above) for 3 minutes. Then rub the surface vigorously with cotton until the blueline image disappears. A slight trace of the image remaining will not interfere with subsequent operations. After the sheet is flushed with water and dried, it may be reused.

h. Multiple-Color Scribing Plastics. Occasionally, the photomapping section requires that two separate images be placed on the same plastic in different colors. This is usually done when part of an existing map is to be revised from new sources. The new detail is superimposed on the old image in a clearly contrasting color, and the photomapper can scribe the revised information to the extent required, and make necessary adjustments to effect a satisfactory tie-in to the old detail, because both images are visible and clearly distinguishable. To process coated plastics with two different-colored images, the platemaker follows a procedure very similar to that used in making composite color proofs. He sensitizes the plastic for the color of the basic image, then exposes and develops that image. He resensitizes the plastic for the second color, exposes the revision copy, and develops that image. Accurate registration of the two images is critical in this type of processing.

–9. Processing Blueline Images for Pen-and-Ink Drafting

a. General. In the mapping field, scribing on plastic, as described in paragraph 7–8, has almost completely supplanted pen-and-ink drafting of blueline images on paper to produce color-separated copy for reproduction. The limited amount of inking still performed by topographic personnel is usually with plastic-solvent ink on the same vinyl plastic used, for coated plastics. In other military printing, however, copy preparation personnel may require positive blueline images on paper for various purposes, such as selective copying of certain parts of a drawing, simplification of an illustration, or color separation. Bluelines on paper are inked in positive form, and film negatives must be prepared from them to make the lithographic plates. Consequently, the blueline image processed by the platemaker must be light enough so that it won't photograph, yet dark enough so that the draftsmen can clearly delineate the desired detail. This requires the use of either bleach or intensifier, as needed, to adjust the color of the processed image.

b. A good quality white paper, with a slightly grained surface and a reasonable amount of stability, such as bristol board, strathmore, or cloth- or metal-mounted paper, should be used. The chemical sensitizing solution is weaker than that needed for bluelines on plastic, since a dark image is not desired. The egg albumin mixture, which serves to bond the sensitizer to the surface of the coated plastic, is omitted when processing on paper, because the paper readily absorbs the coating.

c. The chemicals needed for processing bluelines on paper are as follows:

Stock Solution A	Potassium ferricyanide	120 grains
	Water	30 oz
Stock Solution B	Ferric ammonium citrate	110 grains
	Water	30 oz
Sensitizer	Solution A	1 part
	Solution B	1 part
Intensifier	Ammonium bichromate	¼ oz
	Water	30 oz
Bleach	Ammonium hydroxide	3 oz
	Water	1 gal
	or	
	Oxalic acid	2 oz
	Water	1 gal

d. Procedure. Apply the sensitizer by pouring a small pool of the solution on the paper and spreading evenly over the surface with a paper pad. Apply light pressure to avoid streaks and bubbles. Fan-dry the paper in subdued light. When it is completely dry on both sides, the sensitized paper is exposed to the master negative, emulsion-to-emulsion, in the vacuum frame, with the image right-reading. The arc lamp should be about 36

inches from the surface of the glass. The length of the exposure depends on the intensity of the light and the density of the negative. To develop the image, rinse under clear water for about 1 minute. If the image is too light, it may be darkened by flushing the intensifier solution over the blueline. If the image is so dark that it may photograph, it should be lightened by flushing the bleach solution over the copy.

7–10. Brushsurfacing Lithographic Plates

a. General. At one time, graining press plates was an important part of a platemaker's job, since the smooth surface of the metals then in use did not retain water unless they were mechanically roughened. The bulky, heavy, marble-graining equipment formerly used was replaced by the lighter, smaller brush-surfacers, which produced a finer-grained surface in less time and with fewer personnel. The widespread use by military reproduction units of grainless presensitized plates, chemically treated to retain water, has all but eliminated the need for graining lithographic plates, except to reclaim used plates for additional processing. Both presensitized and wipe-on plates can be reclaimed by this method. After the old image is removed, the plates must be retreated with protective silicate coating, and then resensitized by the wipe-on methods described in paragraph 7–5.

b. Equipment.

(1) The brush lithographic plate surfacing equipment consists of a conventional hand operated floor waxer with twin counterrotating brushes, and a plate holder (fig. 7–7 and 7–8). The plate holding device will fit into a standard size processing sink. Two separate weights, each weighing 2½ pounds, are furnished with the waxer and may be attached when more bearing on the plate is required. A grounded wire should be attached to the cover plate screw of the plug receptacle prior to operating the machine. The plate holding device is made of aluminum and holds a standard lithographic press plate.

(2) The equipment requires no special servicing prior to operation. Operating and maintenance

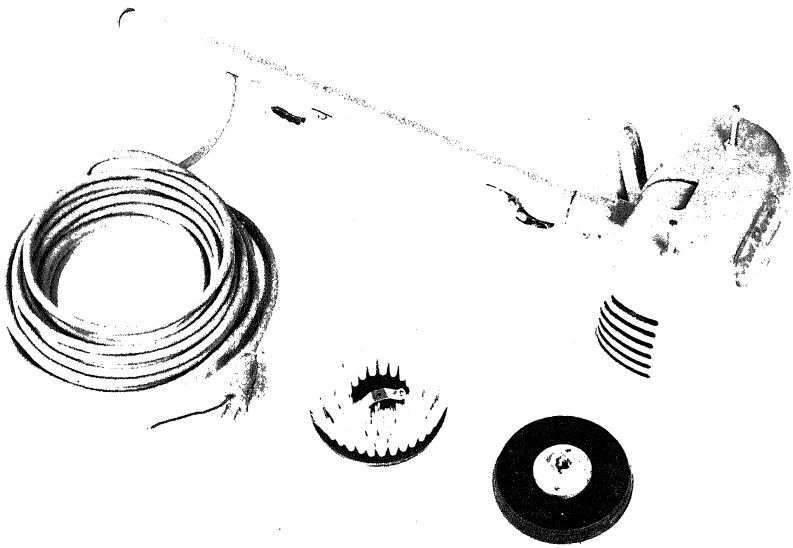


Figure 7–7. Brush-surfacing machine.

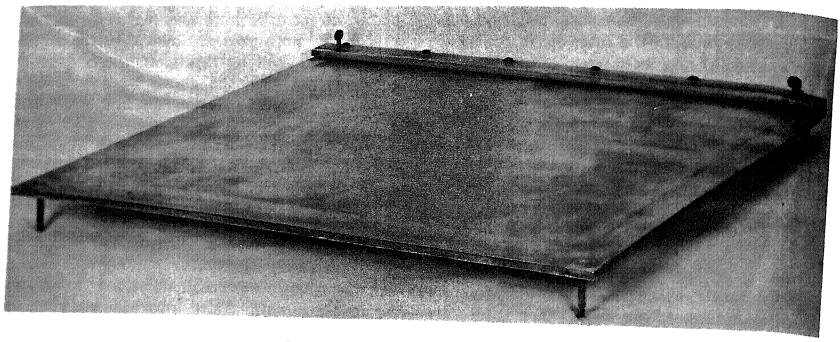


Figure 7–8. Plate holding device.

instructions furnished by the manufacturer should be read and followed carefully. Assembly of the brushing equipment prior to use varies according to the model. When the brush is assembled, it should be thoroughly checked for proper operation before any plates are brushed.

c. Brush-Surfacing Operation.

(1) Place the plate in the plate holder and fasten securely by tightening the set screws.

(2) Remove any ink remaining on used plates with a press wash-up solvent. Rinse with water.

(3) Counteretch the plate for 1 minute with the following solution:

Hydrochloric acid	1 oz
Water	1 gal

(4) Squeegee off most of the counteretch and sprinkle pumice powder evenly over the plate. The pumice powder can be applied with an improvised shaker-top can (fig. 7–9). Small plates, 27¼ by 29½ inches, will take approximately ½ to 1 ounce of pumice powder, while larger plates require 1½ to 2 ounces. If this mixture is too thin, the brush will polish the surface instead of roughening it. Insufficient liquid is indicated if the brush whisks away the pumice.

(5) Brush the plate with long strokes from side to side and up and down, holding the waxer so that both brushes are flat on the surface. Allowing the machine to tilt will result in a polished surface. Use alternate horizontal and vertical strokes over the plate to insure that all portions are evenly grained (fig. 7–10). A stroke across a small plate should last about 2 seconds. Forty to fifty strokes over the entire plate surface should remove any old image and properly prepare the plate. Make sure that the brush strokes overlap each other. Do not hold the brush stationary during this operation as the rotation of the brushes will polish rather than roughen the surface. A slight "ghost image" remaining on the plate can be disregarded, since it will not print. A properly prepared plate has a fairly even, slightly matted texture. Circular brush marks may be visible, but unless the area has a higher polish than the surrounding area, this will not affect the plate.

Figure 7–9. Applying pumice prior to brush surfacing.

(6) Counteretch again by pouring the solution over the plate and allowing it to stand for 30 seconds. Then rinse the plate with running water and use a soft bristled brush to remove residual pumice. Turn the plate over and rinse the back.

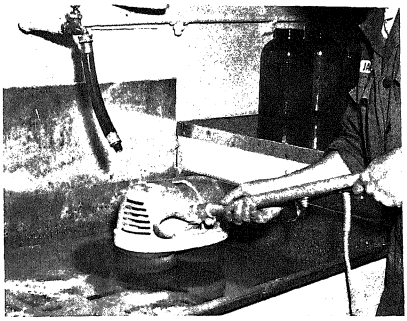


Figure 7–10. Brush-surfacing press plate.

d. Maintenance of Equipment. No special tools are required for maintenance of brush-surfacing equipment. Lubrication of the machine should be performed according to the manufacturer's instructions. In most cases, this will be the addition of grease in the gear boxes. At the end of each day's use, the brushing equipment should be cleaned thoroughly to remove all traces of pumice powder. Brushes should be removed and washed with water. Particular attention should be paid to the underside of the machine where pumice may accumulate. The shafts to which the brushes are attached should be wiped dry and a light coating of oil applied. The sink in which the surfacing is done should also be cleaned and flushed out thoroughly. Once each week inspect the electrical cord for cracks or breaks and repair if necessary. Inspect the motor unit weekly and remove any pumice powder or dirt. The nylon brushes should be inspected periodically for bristle wear. The anticipated lifespan of a nylon brush is approximately 200 small aluminum plates. This lifespan varies according to method of use, maintenance practices, bearing on the plate, and other factors.

CHAPTER 8
OFFSET PRESSES AND OFFSET PRINTING

Section I. INTRODUCTION

8–1. General

a. Offset photolithography is based on the combined talents of many people: camera and film makers, photographers, artists, chemists, platemakers, press manufacturers and pressmen. But the heart of the process, which actually produces the printed lithograph, and for which the other phases are preparatory, is the offset press and its operation.

b. There are many kinds and sizes of presses, and those that are available to each printing plant determine the nature of the preceding phases which prepare material for printing. Presses are categorized by size, model, and maker; as single or multicolor; as rolled-fed or sheet-fed; and by whether they print on one or both sides of the paper in a single press run.

c. The presses used by military printing plants, while they vary in size, model, and maker, are almost all of the single-color, sheet-fed type, printing on one side of the paper. The ATF Model DP (also called the Chief 29) is the standard offset press in Army topographic units, and is the one used in the mobile vans (fig. 8–1). It can accommodate a maximum paper size of 22½ by 30 inches, and a minimum paper size of 11 by 17 inches. The Harris LXG, (fig. 8–2) which is used in some printing plants, has a maximum paper size of 23 by 30 inches, and a minimum paper size of 9 by 12 inches.

d. Other offset presses, the much larger Harris-Seybold Model 145A LUD Offset Press, which handles a sheet size of 35 by 45 inches, and the Model 149 LUN, are not covered in this manual. These presses are used only in base topographic reproduction units. There is usually one of these units in each theater of operations.

e. The general principles governing the operation of offset lithographic presses are illustrated in this chapter by specific references to the ATF Model DP press. Although the principles remain the same, the details of operation and maintenance of other presses may differ somewhat from those described in the following paragraphs. In all cases, the press operator should refer to the operation and maintenance manuals or the manufacturer's instructions for each particular make and model of press he will use, and should be thoroughly familiar with the location and function of the controls and safety devices on each model.

8–2. Safety

Since the presses contain many exposed moving parts such as rollers, gears, chains, and sprockets, great care must be exercised during operation to prevent serious accidents. The following safety regulations should be adhered to at all times.

a. Fatigue jackets or shirts, if worn, shall be worn inside the trousers with sleeves rolled up above the elbows.

b. Remove all rings and jewelry from the hands and any dog tags or necklaces from the neck.

c. Keep tools, rags, chemicals, and solvents in the spaces provided in a neat and orderly fashion.

d. Never use rags or sponges on a running press.

e. Make no adjustments on a running press.

f. Deposit all wastepaper and rags in their proper receptacles.

g. Keep the floor absolutely clean at all times. Use a solvent to clean floors. DO NOT WAX.

h. Safety controls must be on SAFE when the press is not running, and when making adjustments within the press. *They must be taken off SAFE by the same person who put them on.*

i. Do not allow plate etch or gum arabic to remain in contact with the skin for prolonged periods of time.

j. Wipe up all spilled liquids immediately.

k. Read and obey all safety regulations within the pressroom.

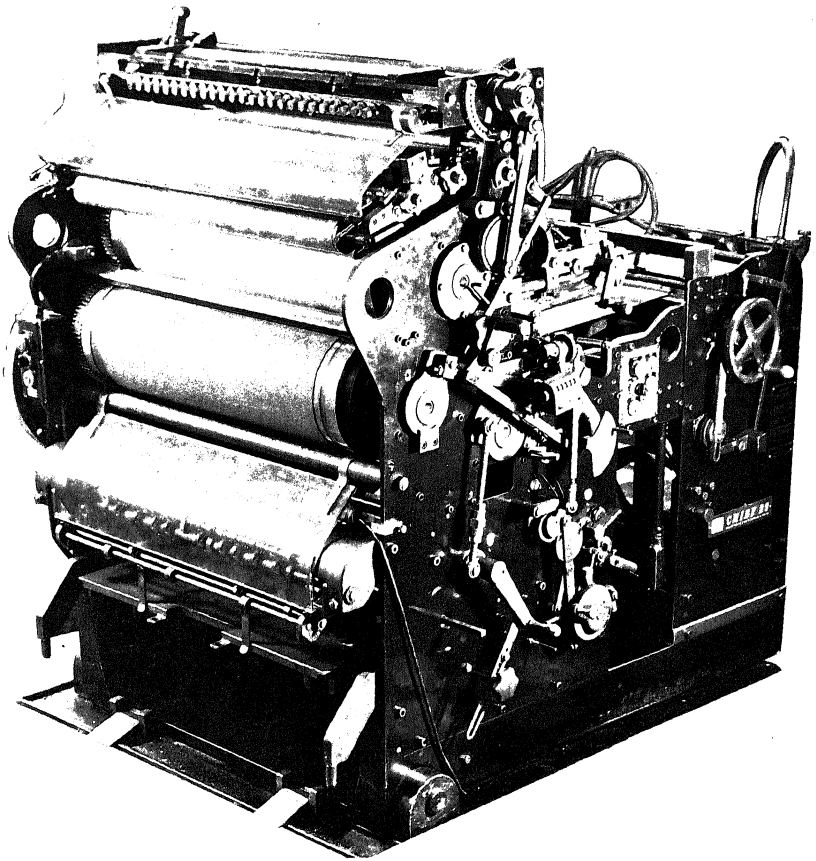


Figure 8–1. ATF Model DP (Chief 29) viewed from the operator's side and showing delivery end.

8–3. Lubrication

An offset press needs periodic lubrication to prevent excessive wear on the parts. Some parts are lubricated with oil, others with grease or gear compound. It is necessary that oiling be done each day, because oil drains from the bearings and other parts if the press stands idle overnight. When any part of the press is lubricated, the press is stopped and the safe switches turned to the SAFE position. The operator should remain constantly alert and safety conscious while lubricating the press. Lubrication instructions for the AFT Model DP Press are contianed in Lubrication Orders LO 5–6021–1 and LO 5–6021–2. Lubrication instructions for other model presses are contained in the pertinent manufacturer's maintenance manual.

8–4. Offset Press Terminology

Before any operations are attempted, it is impor-

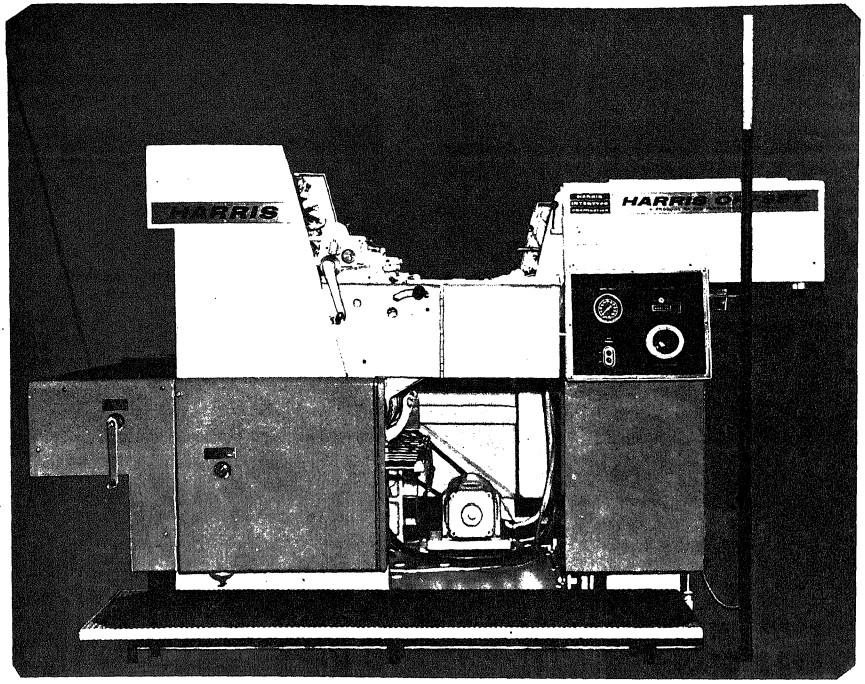


Figure 8–2. Harris LXG Press.

tant to learn and understand the basic terminology which identifies the parts of the press and the assemblies which are necessary to each part of the printing cycle.

a. Figure 8–3 illustrates the basic terms used to locate oneself with relation to the press:

(1) *Feeder end*—where the paper is fed into the press.

(2) *Delivery end*—where the finished printed sheets of paper are stacked by the press. The pressman usually stands here while the press is running.

(3) *Operator's side*—where the controls to operate the press are located. These controls are to the right of the pressman when he is at the delivery end of the press.

(4) *Gear, or flywheel side*—where the gears necessary for the operation of the press are located. These gears are to the left of the pressman when he is at the delivery end of the press.

b. The operation of the offset lithographic press may be divided into two basic cycles, the printing or image cycle, in which the image is transferred from the plate to the blanket cylinder, and the paper cycle, in which the paper is moved from the feeder pile, through the press to receive the image from the blanket cylinder, and is then stacked at the delivery end of the press (fig. 8–4). The major parts and assemblies which accomplish these cycles are as follows:

(1) *Printing cycle:*

(*a*) *Dampening assembly.* The dampening system maintains a supply of dampening solution, usually water with various chemicals added, to keep the nonprinting area of the plate wet. This repels the ink. The dampening assembly must be

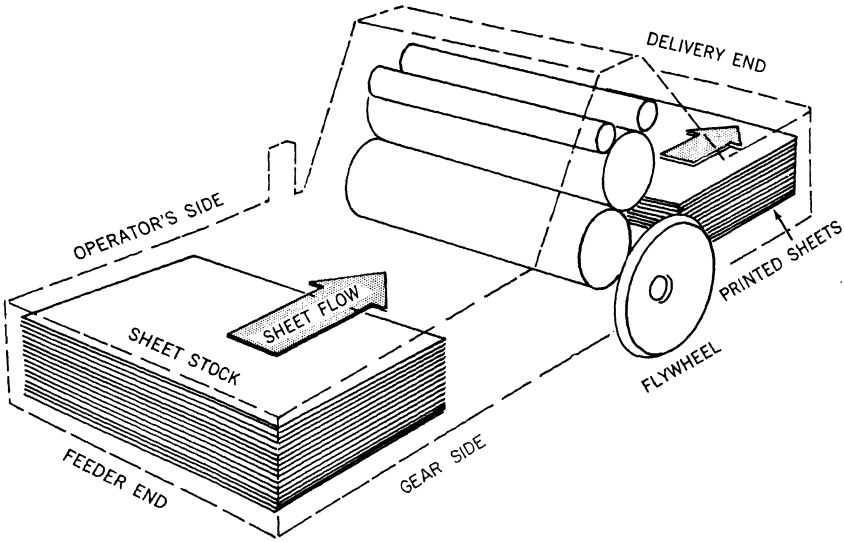


Figure 8–3. Orientation terminology.

put against the plate before the inking assembly to keep the plate clean.

(*b*) *Inking assembly.* The purpose of the inking system is to take the ink from the fountain and move it through a roller system and deposit the ink in a thin, even film onto the image of the plate. The rollers break up the ink particles and spread the ink out in the necessary thin film required for printing.

(*c*) *Plate cylinder.* This cylinder, on which the plate is mounted, is the top cylinder. When the press is in operation, the plate cylinder is in contact with the dampening assembly, the inking assembly and the blanket cylinder.

(*d*) *Blanket cylinder.* The blanket cylinder receives the ink image, in reverse, from the plate and transfers it to the paper carried by the impression cylinder.

(2) *Paper cycle.*

(*a*) *Feeder board assembly.* This assembly separates the sheets of paper and moves them, one by one, down the feed board or conveyor to the impression cylinder.

(*b*) *Impression cylinder.* The impression cylinder is the bottom cylinder and is in contact with the blanket cylinder during the printing cycle. This cylinder is adjustable for pressure against the blanket cylinder. The paper is held on this cylinder to receive the image from the blanket cylinder.

(*c*) *Skeleton cylinder.* The skeleton cylinder drives the feeder and dampening assemblies; it also guides the printed sheet from the transfer point to the delivery board.

(*d*) *Delivery pile assembly.* This assembly receives and stacks the completed printed sheets.

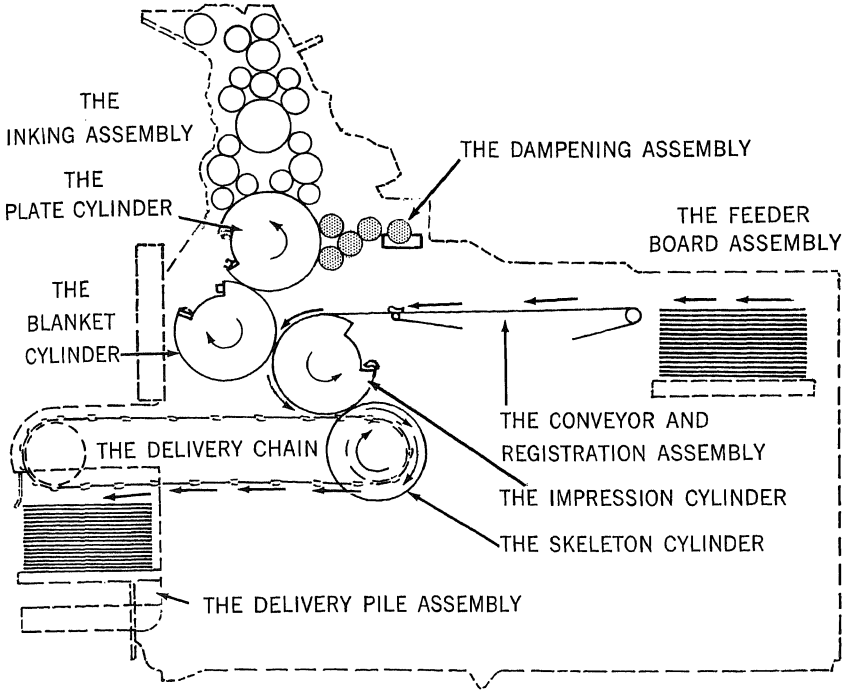


Figure 8–4. A schematic diagram of a typical offset press.

Section II. CONTROLS

8–5. Introduction

The controls system consists of a series of buttons or similar manual or automatic controls used to start, run, vary the speed of, and stop the press. The buttons are set in control boxes or panels located on the press where they can be reached conveniently by the operator. For the location of the controls on the ATF Model DP press, see figure 8–5.

8–6. Nomenclature Relating to Control of the Press

The following tabulated list describes the parts which provide the controls for the ATF Model DP press, and their specific functions (figs. 8–5 and 8–6). Controls on other presses may vary somewhat in location and appearance, but in general, will have similar functions.

Part	Function
Stop button	Used to stop the press. After the stop button is pushed, the press will continue to turn, making three to six revolutions before coming to a complete halt.
Jog, safe, run button. Start button.	If the arrow on the button is pointing to the jog position, the press can be jogged or inched by pressing the start button located immediately below the *jog, safe, run* button.
	If the arrow is pointing to "safe", all power to the press is disconnected.
	If the arrow is pointing to "run" and the start button is pushed, the press will begin running continuously.

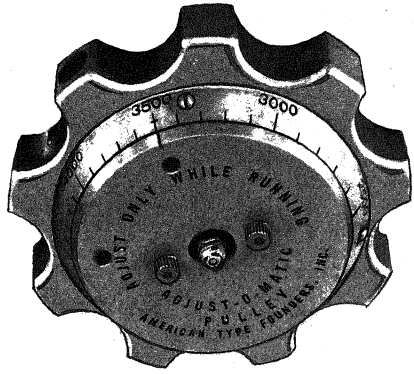


Figure 8–6. Mechanical variable speed control.

Section III. FEEDER ASSEMBLY

8–8. Introduction

The feeder assembly on an offset press is that part of the paper-handling cycle which separates each sheet of paper, positions it, and passes it into the printing cycle. The feeder assembly consists of two subassemblies. The first is the feeder board with its related sheet handling devices, such as the air blast mechanism (fig. 8–7), which "floats" the top few sheets up from the rest of the pile of paper stock, and the sucker mechanism (fig. 8–8), which picks up the top sheet and moves it forward. The second subassembly is centered about the conveyor board with its related sheet-transporting equipment and sheet-positioning or registering guides, such as illustrated in figure 8–9.

8–9. Nomenclature for Feeder Assembly

Part	Function
Feeder board	Holds the paper stock to be run through the press. The feeder board rises automatically and allows the sheets to be fed into the press continuously. It may also be raised or lowered manually to permit loading of paper stock (fig. 8–7).
Feeder board elevating handwheel.	Used to raise or lower the feeder board manually (fig. 8–10).
L-shaped pile guide bars.	Used, along with the front pile guide bars and the corner brackets, to hold the stock in a neat pile for feeding (fig. 8–7).
Front pile guide bars	Used, along with the L-shaped pile guide bars and the corner brackets, to hold the stock in a neat pile for feeding (fig. 8–7).
Sheet separators	Steel spring fingers located on the inside edge of the front pile guide bars. They help to prevent more than one sheet from feeding into the press at a time (fig. 8-7).
Pile height governor	Regulates the height of the top of the pile as it is rising automatically (fig. 8-11).
Corner brackets	Used, along with the tail weights, to told the stock against the pile guide bars (fig. 8–11).
Tail weights	Used, along with the corner brackets, to hold the stock against the pile guide bars. They keep the sheets from floating back when the airblast is turned on (fig. 8–11).
Air pump	Used to provide both airblast and suction to enable the airblast mechanism and the suction mechanism to function (not illustrated).
Air blast adjustment knobs.	Used to increase or decrease both the overall airblast (large knob) and the airblast at the individual nozzles (smaller knobs) (fig. 8–12).
Air blast nozzles	Used to "float" the top few sheets up from the rest of the

Part	Function
	sheet pile so that the suckers can grasp the top sheet and move it forward (fig. 8–7).
Wale floating side nozzles.	A patented type of "floating" nozzle which adjusts itself automatically to the top of the pile (fig. 8–7).
Suckers	Used to pick up the top sheet and carry it forward to the point where the pull-in wheels and conveyor tapes carry it forward (fig. 8–8).
Sucker bar	The mounting for the suckers, located at the front edge of thesheet pile (fig. 8–8).
Air suction lever feeder valve.	Must be closed, with air pump turned on, for the suckers to function (fig. 8–13).
Suction control	Used to vary the amount of suction (fig. 8–14).
Conveyor tapes	Used to carry the sheets down the conveyor board to the front guides (fig. 8–15).
Pull-in wheels	Used to grasp the sheet when it is released by the suckers and move it forward onto the conveyor board (fig. 8–15).
Two-sheet choke or caliper.	Prevents two sheets from going down the conveyor board simultaneously (fig. 8-15).
Sheet flattener bar, or drop bar.	Used to keep the sheet from buckling while being pushed by the side guide (fig. 8–9).
Front guide bar or head stop shaft.	Used to hold and position the front guides (or head stops) and the head stop shaft sheet guides (fig. 8–9).
Gripper edge sheet guides or head stop shaft sheet guides.	Used to hold down the front edge of the sheet to insure that no grippers fail to grip the sheet (fig. 8–9).
Front guides or head stops.	Used to stop the sheet and position it before it is transferred to the impression cylinder (fig. 8–9).
Under tongues	Used in conjunction with the front guides to support the sheet and keep it from slipping under the guides (not illustrated).
Gripper (on impression cylinder).	Used to carry the sheets past the printing pressure point and then release them to the delivery assembly (fig. 8-9).
Side guides	Used to insure that every sheet is printed in exactly the same lateral position (fig. 8–9).
Sheet guards	Used to keep the sheets flat as they travel down the conveyor board and to prevent them from jamming against the side guide or the sheet flattener bar (fig. 8–9).
Register wheels	Used to prevent the sheets from bouncing back from the front guides (fig. 8–16).
Rider balls	Used to help maintain registration (fig. 8–16).
Brushes	Used to help maintain registration (not illustrated).

8–10. Operational Instructions

a. Loading Feeder Board.

(1) *Creasing first sheet.* When preparing to load paper stock on the feeder board, take a single sheet of the stock to be run and fold it exactly in half with the crease running along the short dimensions of the sheet. Note that the top of the feeder board has three small etched lines—a center line and left and right lines ⅛ inch apart—extending in from the edge of the board closest to the press mechanism. Place the creased sheet on the feeder board with the center crease ⅛ inch off the center of the feeder board. Whether the crease in the sheet is alined with the left line or the right depends on which side guide is to be used to aline the sheet laterally just before it receives its impression. If the side guide on the operator's side of the press is to be used, which is the normal procedure when printing maps on one side of a sheet only, aline the crease in the sheet with the etched line on the operator's side of the center line.

(2) *Setting forward pile guides.* After positioning the folded sheet on the feeder board, bring in flush against the sheet the L-shaped pile guide bar on the side guide side (fig. 8–7). Bring the other L-shaped bar in and set it approximately $\frac{1}{16}$ inch from the edge of the sheet on the opposite side. The front pile guide bars normally need not be moved. They merely help keep the front edges of the sheets alined. Take care that the corner pile guide bars are not set too tight against the pile for they will bind the sheets, causing poor feeding and registration troubles.

(3) *Winding and jogging stock.* Stock that is to be placed on the feeder board must be winded and jogged. This consists of first, fanning the stock so that air can enter between the sheets, permitting the top sheet to separate easily from the pile; and second, straightening the pile so that each sheet will be carried down the conveyor board over the same path, helping to insure accurate register. The stock is best handled in lifts of about 100 sheets. The corners of the stock may be

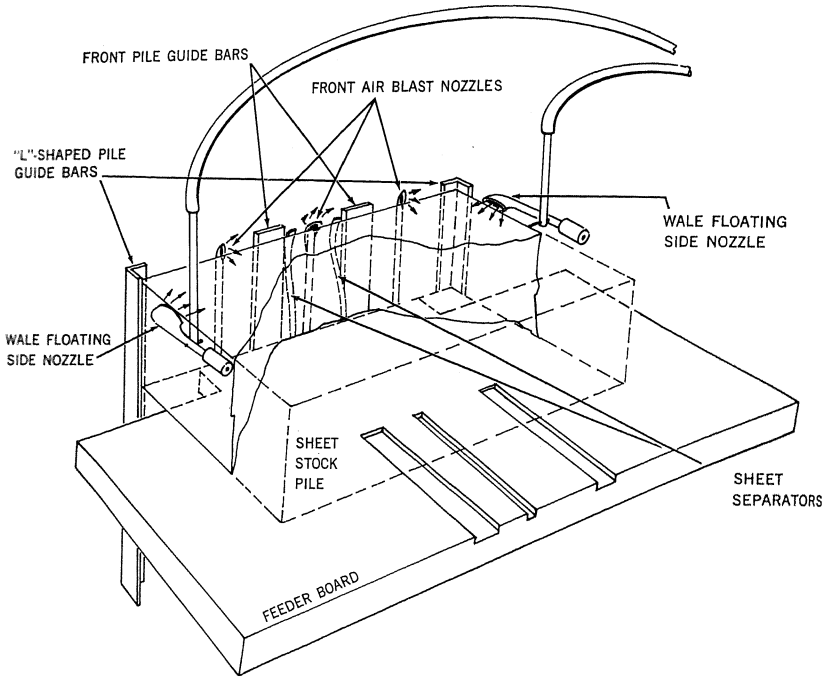


Figure 8–7. Air blast nozzles, front pile guide bars, and sheet separators.

raised and ruffled, and the paper worked back and forth in such a manner as to permit air to enter between, and separate each sheet. It is easy to tell when a sufficient amount of air is between the sheets because the paper will then slide back and forth very easily. After winding, the sheets are bounced against a flat surface so that the edges are flush with each other. If the sheets are not jogged carefully, they do not feed into the press properly, and poor feeding and misregister result.

(4) *Loading feeder board.* With jogging completed, place the lift of stock on the feeder board without disturbing the stock below it. Do not pull back the lift of sheets and jog them forward against the pile guide bars unless all the pile is so jogged at the same time.

(5) *Setting pile height governor.* Set the pile height governor next. This is very important because if the pile is too low, the sheets will not be picked up by the suckers. If the pile is too high, the suckers may pick up two or more sheets simultaneously. Place the pile height governor about 2 inches from the rear edge of the pile. To set the pile height governor, bring the suckers to their lowest position by turning the press flywheel by hand. Then raise the pile by turning the feeder board handwheel (fig. 8–10) until the top of the pile is about ¼ inch below the sucker feet. Then, using the flywheel, turn the press until the pile height governor moves to its lowest position. Next, adjust the pile height governor upward or downward until the bottom of the governor just touches the top of the pile. At this point, start the press (only after making certain that it is clear) and check to see that the feeder board does not attempt to rise any more. An additional check can be made by lowering the pile manually and starting the press to see if the pile rises to the desired height by itself. Once the pile height governor is set, it need not be set again unless feeding prob-

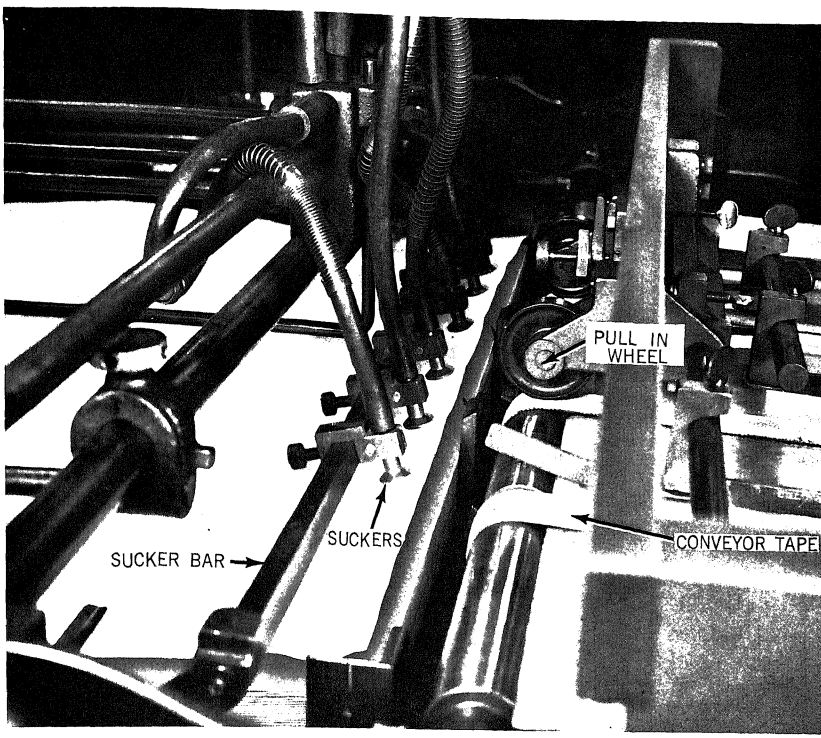


Figure 8–8. Sucker action.

lems are encountered. Tighten the knurled screw and locking nuts in order to retain the desired setting. When feeder troubles occur, check the pile height governor first.

(6) *Setting rear pile guides* (fig. 8–11). Complete the loading of the feeder board by setting the corner brackets and tail weights. These push the entire pile lightly forward against the front pile guide bars. Do not set the corner brackets and tail weights too tight because they will bind the sheets, causing feeder troubles.

b. Adjusting Air Blast and Suction Mechanism. (The procedure varies slightly among different models of presses.)

(1) *Adjusting air blast mechanism.* Locate the air pump, the controls for the air pump and the air blast adjustment knobs or knurled screws. The knobs on the ATF Model DP (fig. 8–12) operate in the following manner: one complete revolution brings the adjustment back to the same place. There are one large and three small knobs. The large knob controls the overall amount of air blast, one of the small knobs controls the side air nozzle, and the other two small knobs control the three front air nozzles. All the air blast nozzles are adjustable for height and lateral positioning. Adjust the nozzles for the width and length of the pile to be run through the press. See that all locknuts are tightened after making the necessary adjustments.

(2) *Adjusting suction mechanism.*

(*a*) Space the suckers across the sucker bar to conform to the size of the stock to be run. Exercise care when positioning the suckers so that they do not contact other parts of the feeder mecha-

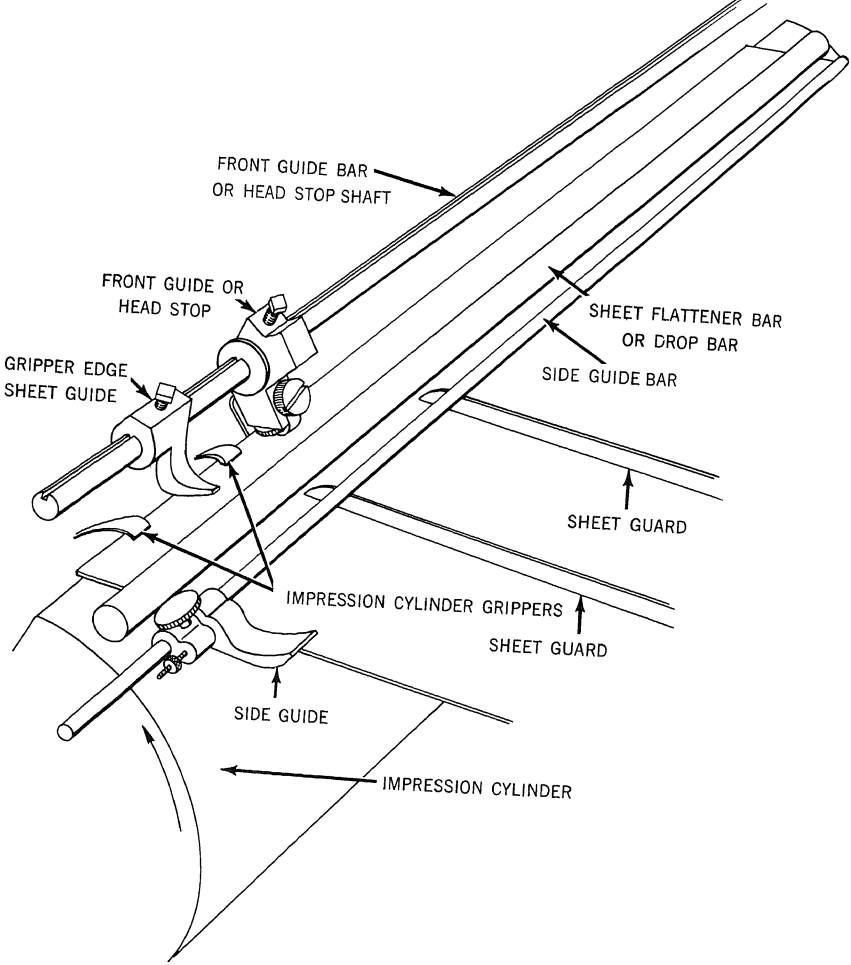


Figure 8–9. Sheet guides and other sheet registering devices.

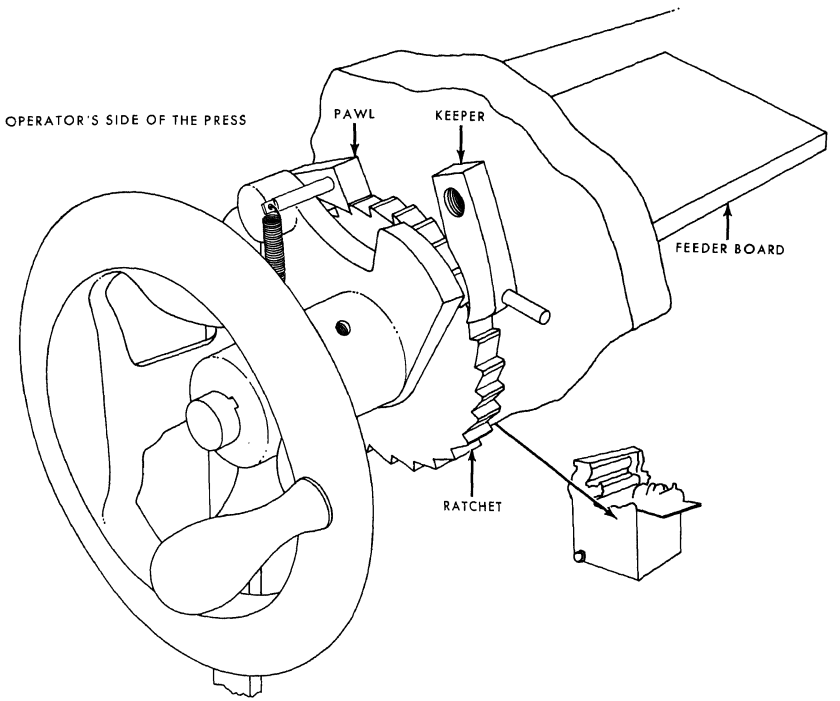


Figure 8–10. Handwheel for manually raising and lowering feeder board.

nism while the press is in motion. Do not position the suckers over the conveyor tapes, as some weights of stock will not have sufficient clearance between the tapes and the suckers. Check all positioning and clearances by turning the flywheel by hand and observing the motion of the sucker bar through a full cycle.

(*b*) Two types of suckers are furnished with the ATF Model DP press. For heavy stocks, rubber suckers are provided. For lighter stocks, such as map maper, brass suckers are provided. The rubber suckers need no specific positioning. The metal suckers must be positioned so that the open end of the V-shaped slot in the bottom of each sucker is facing the delivery end of the press.

(*c*) The amount of suction required for best results varies with different weights of stock. The suction control is located on the gear side of the ATF Model DP press (fig. 8–14). The construction of the adjustment varies slightly on different press models. However, the principle is the same on all presses—the smaller the opening, the greater the amount of suction at the suckers; the larger the opening, the less the suction.

(*d*) In order to pick up sheets from the feeder board, suction must be started and supplied to the suckers. Start the air pump by pressing the blower start button and then close the feeder valve, as indicated in figure 8–13, to establish suction at the suckers.

(*e*) The suction is timed by a cam on the gear side of the press. This cam is located just below the front edge of the conveyor board. As the sucker bar drops, while the press is operating, the cam causes a cover to close the suction inlet, pulling air through the suckers and picking up a

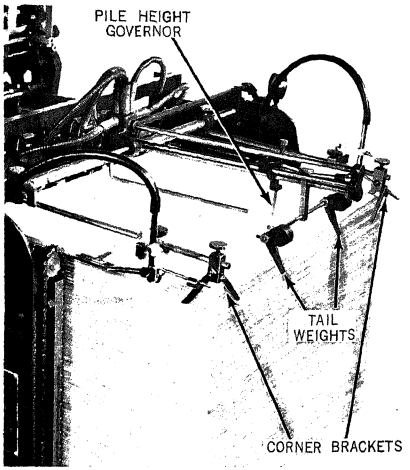


Figure 8–11. Feeder board rear pile guides.

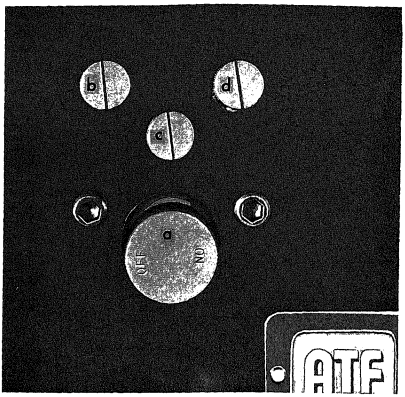


Figure 8–12. Air blast controls on ATF Model DP.

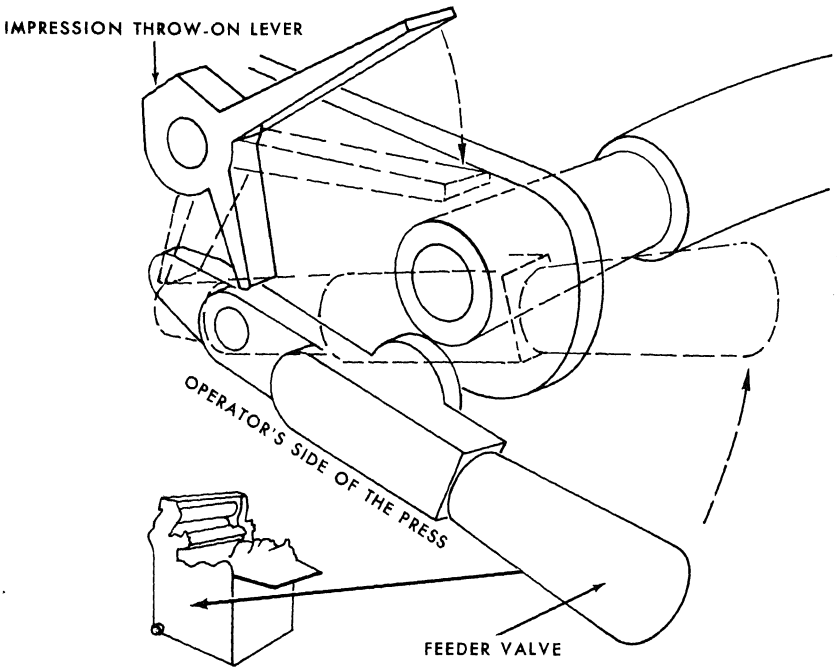


Figure 8–13. Feeder valve, or air suction lever.

sheet. When the suckers reach their highest point, the cam opens the suction inlet, causing the suckers to release the sheet.

(3) *Sheet separators* (fig. 8–7). The sheet separators need not be adjusted until a different type of paper stock is used. They are set so that the hook on the top of the separator protrudes slightly over the top sheet on the pile when the airblast is on. Use care when setting the sheet separators because they are very easily bent. If it is necessary to adjust the separators, make sure that the safe switches are in the "safe" position.

c. Adjusting Sheet Transporting and Positioning Equipment on Conveyor Board.

(1) *Adjusting conveyor tapes and pull-in wheels.* The tension on the conveyor tapes can be varied by adjusting the idler rollers under the conveyor board. This adjustment does not have to be made very frequently. The pull-in wheels should be set with equal tension or pressure against the conveyor tapes so that the sheets move uniformly. Unequal pressure between the two pull-in wheels will cause the sheets to twist or slow down as they pass down the conveyor board. The pull-in wheels

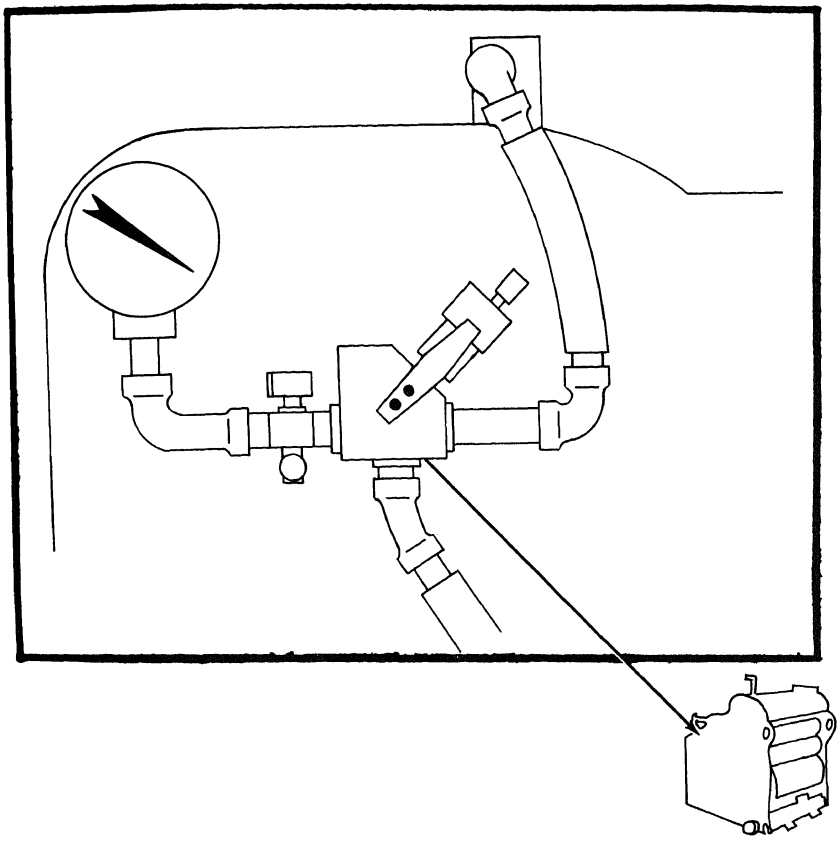


Figure 8–14. Suction control—ATF Model DP.

are adjusted by thumbscrews located behind each wheel (fig. 8–15). Turning the thumbscrews clockwise will lessen the pressure. The safe switches must be in the "safe" position when making this adjustment.

(2) *Adjusting two-sheet choke.* Set the two-sheet choke, or caliper, so that only one sheet of the stock being run can pass through at one time. On the feeder board side of the two-sheet choke are a thumbscrew and locking bar which are the means of adjustment. Insert a piece of the paper stock being run under the choke. There should be no drag on the single sheet of paper as it passes under the choke. Turn the thumbscrew counterclockwise to tighten the pressure on the sheet and clockwise to lessen the pressure. Then try two sheets of paper. They must not be able to pass through the choke simultaneously. Check the press to make sure safe switches are in the "safe" position before making this adjustment.

(3) *Adjusting front guide bar.* Adjust the front guide bar so that it is parallel to the leading edge of the impression cylinder and place it in the center of its adjustment range before the start of every run. Make this adjustment by turning a horizontal screw at each end of the bar. To make the adjustment, turn the screws all the way in (clockwise) and then out (counterclockwise) two full turns. This will set the screws in the center of their adjustment range of four full turns, and also make the front guide bar parallel to the leading edge of the impression cylinder. Never turn the screws out more than four full turns or the impression cylinder gripper fingers will not grasp the sheets properly. To position sheets, the front guide bar can be adjusted to make slight changes in the gripper margin. This must be done only after the plate has been twisted as far as possible (para 8–16*g*(1)), or when the adjustment is very small. The gripper edge margin is increased by turning the horizontal front guide bar adjusting screws in (clockwise) and decreased by turning the screws out (counterclockwise).

(4) *Adjusting front guides.*

(*a*) Adjustment of the front guides shall be made only by a press erector or senior pressman, but the following instructions for adjustment are presented for the general information of the inexperienced pressman.

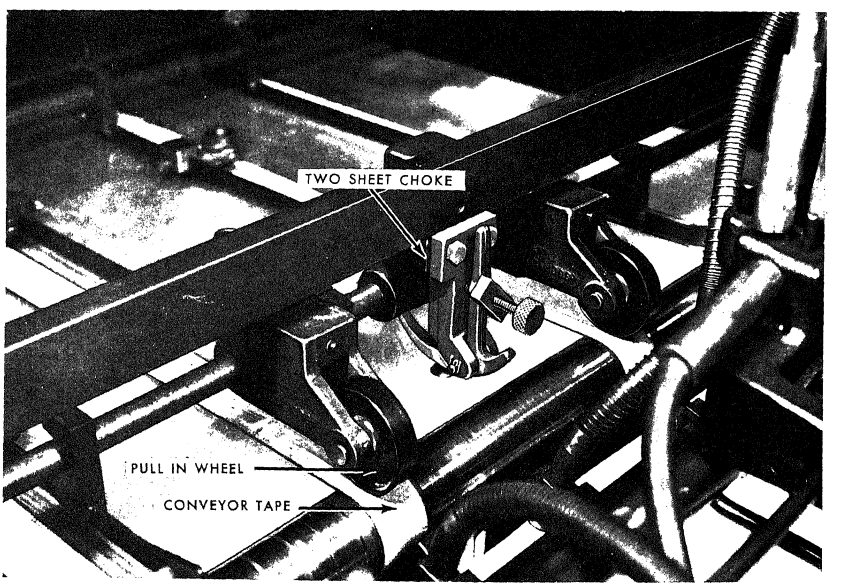


Figure 8–15. Two-sheet choke or caliper.

(*b*) The individual front guides must be adjusted so that they are perfectly parallel with each other and with the leading edge of the impression cylinder. The adjustment for this is a horizontal knurled screw, located on the feeder side of each front guide. The minimum gripper bite is 3/16 inch, and the maximum gripper bite is 5/16 inch. Safe switches must be in the "safe" position before making this adjustment.

(*c*) Each front guide has an adjustment to compensate for different thicknesses of stock. It is a vertical knurled screw, located at the bottom of the guide. This screw adjusts the distance between the spring-steel part of the front guide and the undertongue. The undertongues are pieces of spring steel, mounted on a bar under the conveyor board. They fit between the guiding portion of each front guide and the surface of the impression cylinder. The function of undertongues is to prevent sheets from sliding under the front guides into the impression cylinder gap. They must be set to clear the surface of the impression cylinder by .005 of an inch. This adjustment must also be made by a press erector or senior pressman only. The spring steel part of the front guides is adjusted to allow the stock being run to pass through with about .002 of an inch clearance. The gap between the undertongue and the spring steel part of the front guide is increased by turning the vertical knurled screw out (counterclockwise) and decreased by turning the screw in (clockwise).

(5) *Setting side guides.*

(*a*) When the front guides stop a sheet of stock as it is moving forward and hold it until it is grasped by the impression cylinder grippers, the sheet is then positioned properly for impression in one direction, but it is not yet properly positioned laterally. This action is accomplished by the side guide which pushes the sheet from the side to its proper side-to-side position.

(*b*) To set the side guide, feed a sheet from the feeder pile to the front guides. First, start the air pump; then close the feeder valve; then "inch" the press until the sheet hits the front guides and the impression cylinder gripper fingers are ¼ of an inch from closing. At this point, the side guide bar will be at the limit of its inward thrust. Loosen the vertical knurled screw on top of the side guide, move the side guide inward until the vertical flange contacts the sheet, and move both the guide and the sheet inward ⅛ of an inch. This is the recommended side guide push. Any more than ⅛ of an inch push will buckle the sheet or interfere with its travel, while less than ⅛ of an inch push may cause the side guide to misregister some sheets.

(6) *Side guide changeover.*

(*a*) Two side guides, one on the operator's side of the conveyor and the other on the gear side, are provided to permit accurate registration when printing backup work (i.e., printing both sides of a sheet), although only one side guide is used at a time. By switching from one to the other, it is possible to register a sheet from the same edge when printing on the reverse side. If the side guide arm is on the lower stud and the spring is on the near stud (fig. 8–17a), the push of the side guide comes from the operator's side.

(*b*) To change the side guide push to the gear side of the press, the following procedure is used: Release the spring from the near stud; remove the pin and keeper from the side guide arm and place the arm on the upper stud; then insert the pin and keeper in the same place in the side guide arm; and attach the loose end of the spring to the stud on the conveyor board (fig. 8–17b). The side guide will now push from the gear side of the press.

(*c*) To change the side guide push to the operator's side, the reverse procedure is used. First, remove the end of the spring from the conveyor board stud. Then remove the pin and keeper and place the side guide arm on the lower stud. Insert the pin and keeper in the same place in the side guide arm and place the spring on the near stud. The side guide is now ready to push from the operator's side of the press. The safe switches must be in the "safe" position when making the side guide changeover.

(7) *Adjusting sheet flattener bar.* The sheet flattener bar, or drop bar (fig. 8–9), located between the front guide bar and the side guide bar, is timed to drop against the sheet just before the side guide pushes it. To set the sheet flattener bar, the press must be in the same position as it was when the side guide was set (i.e., with the impression cylinder gripper fingers ¼ in. from closing). On the ATF Model DP the adjustment is made with a vertical screw at the end of the bar on the gear side. A knurled locknut is provided to lock the adjustment. Raise the bar by turning the screw in (clockwise) and lower it by turning the screw out (counterclockwise). Set the bar to just barely touch the sheet. When running very thin paper, set the bar slightly lower in order to form a trough across the sheet. This trough gives added strength to the sheet to help prevent it from buckling. Do not set the bar too low, however, or it

will cause the sheets to slow down and miss the impression cylinder grippers.

(8) *Setting sheet guards.* The sheet guards are raised above the conveyor board and run parallel to the direction of the sheet travel. They are adjustable and can be positioned to properly handle various sizes and types of paper stock. Do not position the sheet guards where they could interfere with the operation of the suckers. Use the flywheel to turn the press until the sucker bar is at its most forward position; then locate the sheet guards.

(9) *Setting register wheels.* The register wheels must always be adjusted in two ways: They must be adjusted by their tension springs so they ride against the conveyor tapes with equal tension; they must also be adjusted so that they barely touch the tail edge of the sheets when the sheets are against the front guides. On stock that is less than 22 inches long, position the register wheels to ride on the inner conveyor tapes. On stock longer than 22 inches, position the register wheels to ride on the two outer conveyor tapes. On stock that is less than 15 inches wide, it may be necessary to place an extra set of register wheels about 7 inches in front of the pull-in wheels to keep tension against the sheet during its travel down the conveyor board (fig. 8–16).

(10) *Other registration devices.* Offset presses are commonly equipped with two other devices to help maintain registration by adding weight to the sheet.

(*a*) *Rider balls* can be attached to the sheet guards. The rider balls should be positioned above the conveyor tapes, or they will slow down the sheets.

(*b*) *Brushes* also can be attached to the sheet guards. The brushes may be placed wherever the operator desires for best results with various sizes and conditions of paper stock.

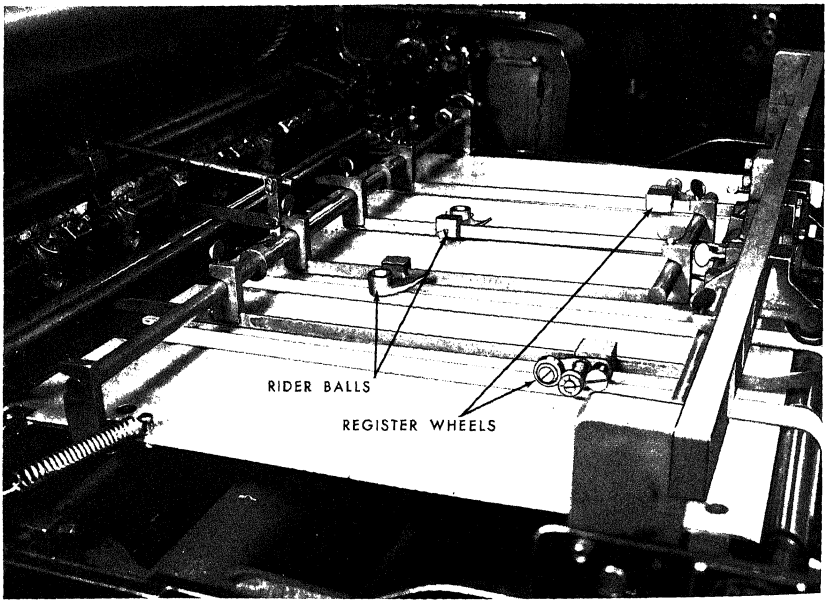


Figure 8-16. Register wheels and other registration devices.

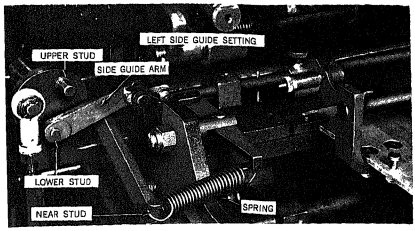


Figure 8-17. Side guide setting for push from operator's side.

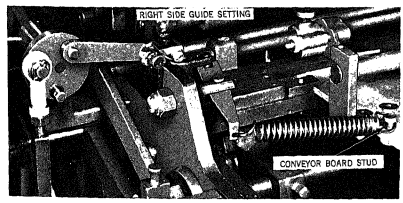


Figure 8-17—Continued.

Section IV. DELIVERY ASSEMBLY

8-11. Introduction

The delivery assembly on the ATF Model DP press is that part of the paper-handling cycle which, after the sheets have been carried past the printing pressure point by the impression cylinder grippers, carries the printed sheets to the delivery board by a system of chain-driven, cam-operated delivery gripper fingers. In addition, the delivery assembly jogs the sheets into a neat, even pile on the delivery board, permitting easy, post-press handling of the sheets. Figure 8-18 illustrates the action of the delivery assembly in a simplified sketch.

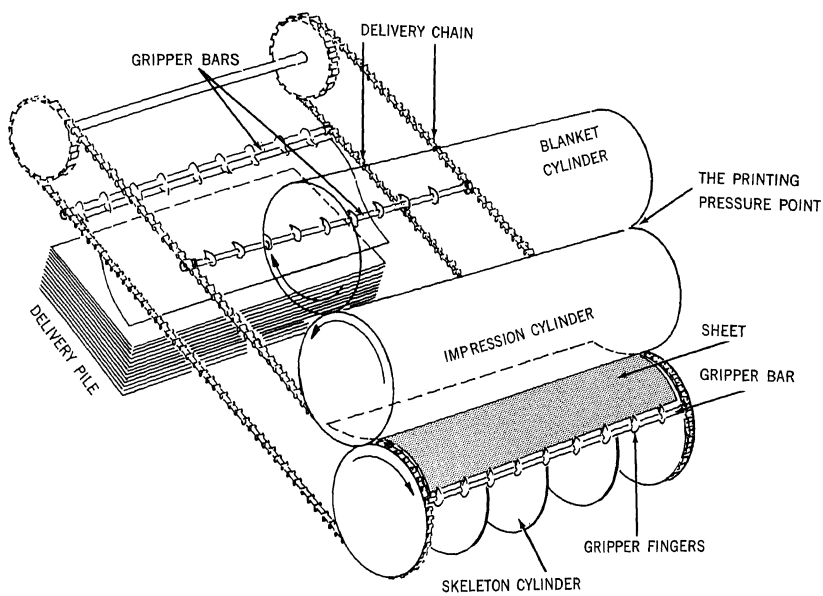


Figure 8-18. Delivery assembly (schematic sketch).

8-12. Delivery Assembly Nomenclature

Part	Function
Gripper bars	Used to transfer the sheets from the impression cylinder to the delivery board. Each of the gripper bars has nine delivery gripper fingers (fig. 8-18).
Delivery gripper fingers.	Used to grasp the sheet from the impression cylinder grippers and carry the sheet to the delivery board (fig. 8-18).
Skeleton cylinder	Used to drive the feeder system and the delivery system (fig. 8-18).
Sheet stops	Used to keep the sheets from dropping over the edge of the delivery board after they have been released by the delivery gripper fingers (fig. 8-19).
Stripper fingers	Used to strip off any sheets that may stick to the delivery gripper fingers (fig. 8-19).
Delivery board	Receives the sheets when they are released from the delivery gripper fingers (fig. 8-19).
Jogger blades	Used to keep the pile of sheets on the delivery board neat and even (fig. 8-19).
Automatic pile receder.	Allows the delivery board to lower automatically at a rate of speed determined by a pawl and ratchet attached to the manual handle (fig. 8-20).
Manual control handle.	Used to lower (or raise) the delivery board manually (fig. 8-20).

8-13. Operational Instructions

In contrast to the feeder assembly, which requires many small adjustments, the delivery assembly operates automatically, for the most part. There are no operational adjustments to be made to the delivery gripper fingers or gripper bars, nor to the skeleton cylinder, nor to the sheet stops or stripper fingers. Only the jogger blades and the delivery board are adjusted or set by the operator in normal operations.

a. Setting Jogger Blades. To set the jogger blades, loosen the thumbscrew on the two side blades, and move the blades outward so they will not interfere with the sheet as it drops down to the delivery board. Then inch a sheet of stock through the press and allow it to drop to the board. Take care that the sheet is positioned directly below the point where the delivery gripper fingers release the sheet. Inch the press until the blades at the back of the delivery board have moved forward their maximum distance. This point is reached when one of the gripper bars has just reached the upper level on the delivery chain cycle. Then move the side blades inward until they contact the sheets snugly, and retighten their thumbscrews. After making certain that the sheet is touching the sheet stops on the front edge of the board, loosen the knurled screws on the back jogger bar and move the bar forward until its blades come in contact with the tail edge of the sheet. Then retighten the knurled screws on the back jogger bar.

b. Setting Automatic Pile Receder. To adjust the automatic pile receder (fig. 8-20), engage the pawl and raise the pawl control handle to the desired position. The higher the handle is raised, the greater the rate at which the delivery board will lower. The thicker the stock, the greater the lowering rate at which the delivery board must be set. The feeder valve must be closed in order to make the automatic pile receder operate.

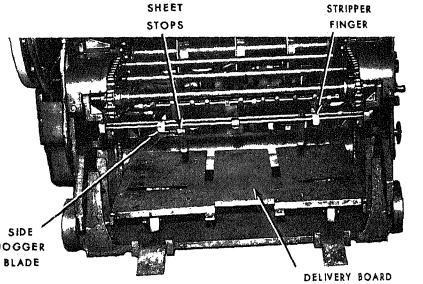


Figure 8-19. Delivery assembly.

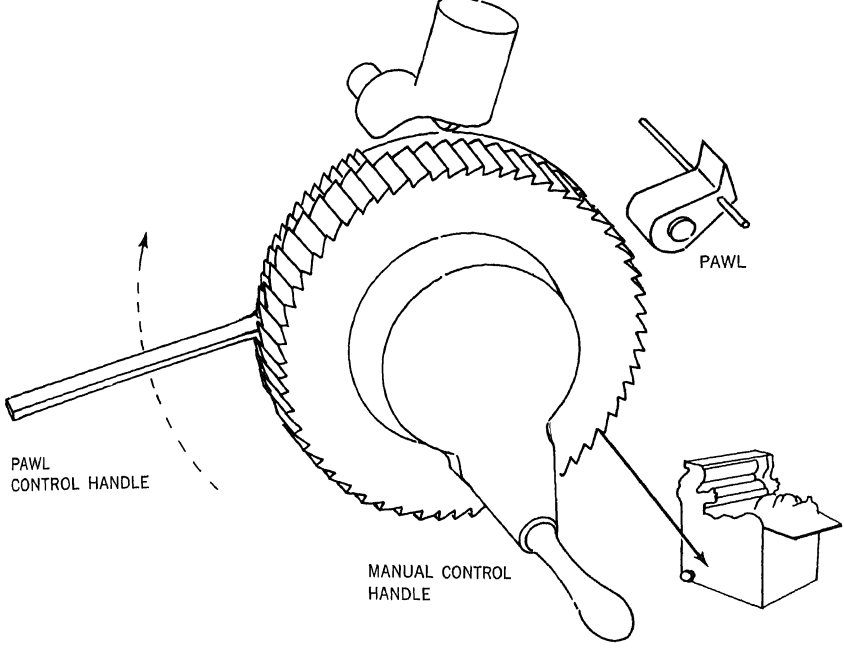


Figure 8–20. Delivery board lowering mechanism.

Section V. CYLINDER ASSEMBLY

8–14. Introduction

The cylinder assembly transfers the inked image from the plate to the blanket and then to the paper. On the ATF Model DP press, the assembly consists of the three main cylinders—the impression cylinder, the blanket cylinder, and the plate cylinder—which constitute the "heart" of the offset press. The impression cylinder grasps the prepositioned sheet at the front guides and carries it into contact with the blanket cylinder. Meanwhile, a plate mounted on the plate cylinder is inked and it transfers its image to a rubber blanket mounted on the blanket cylinder. The blanket, in turn, transfers or "offsets" the image to the sheet of paper on the impression cylinder. The impression cylinder continues to revolve and carries the printed sheet around to the point where the sheet is transferred from the grippers on the impression cylinder to the delivery gripper fingers on the gripper bar. See figure 8–21 for a simplified presentation of the cylinder assembly.

8–15. Cylinder Assembly Nomenclature

Part	Function
Plate cylinder	Carries the plate and revolves so as to bring it into contact, first, with the dampening assembly; second, with the inking assembly; and, last, with the blanket (fig. 8–21).
Plate clamps	Metallic bars attached to plate cylinder, used to position and tighten the plate.
Plate	Carries the image which, when it is inked, makes the impression on the blanket (fig. 8–21).

Part	Function
Cylinder undercut	A recess of the surface of a cylinder relative to its bearer ring which allows space for the plate or blanket to be added plus any packing which might be needed (fig. 8–22).
Packing	Sheets of paper placed under a blanket or a plate to increase the circumference of either (not illustrated).
Bearers	Steel bands encircling the outside edge of each cylinder and used to maintain correct separation between cylinder surfaces (fig. 8–22).
Blanket cylinder	Carries the blanket, bringing it into contact, first, with the plate, and second, with the sheet to be printed (fig. 8–21).
Blanket	Carries the image from the inked plate to the sheet (fig. 8–21).
Blanket bar	Metallic bars attached to both ends of the rubber blanket and used to hold the blanket taut against the blanket cylinder (fig. 8–23).
Impression cylinder	Grasps the prepositioned sheet at the front guides and carries it into contact with the blanket cylinder (fig. 8–21).
Impression trips	When they are activated, they cause the blanket cylinder to move away from the plate and impression cylinders. The press is then "off impression." Two of these are manual. The third is automatic and trips the press "off impression" should a sheet fail to reach the finger on the automatic trip at the prescribed time (fig. 8–29).
Counter	Records the number of impressions the press makes while it is "on impression" (not illustrated).
Impression cylinder adjustment handle.	Used to adjust the pressure between the blanket cylinder and the impression cylinder to obtain the correct printing pressure when printing on various thicknesses of stock or when the thickness of the blanket and packing on the blanket cylinder has been changed (fig. 8–24).

8–16. Operational Instructions

a. Cleaning Plate and Plate Cylinder Before Mounting Plate. Before a quality job can be produced, the plate and all cylinder surfaces and bearers must be clean.

(1) *Cleaning plate.*

(*a*) Cover the working area with clean paper and place the plate on it, image side down. Use a clean, soft, water-saturated cloth to wipe the back of the plate thoroughly. The types of dirt most likely to be found on the back of the plate are accumulations of gum arabic, which get stuck on the rear of the plate while the image side is being covered with a protective coating of gum, and grit, which may get on the back of the plate as it is handled by the plate maker. Dirty areas, which project above the smooth surface of the back of the plate, can be found by sliding your hand over the plate surface.

(*b*) If any dirt remains after wiping with a wet cloth, scrub the dirty area with an ink solvent and/or pumice powder. The smallest lump of dried gum or grain of grit can cause a high spot to develop on the plate when it is mounted on the cylinder. Such high spots can be the source of a great amount of difficulty when the plate is inked for printing.

(*c*) When using any of these cleaning methods, take special care that none of the materials used injure the image on the plate. Water will dissolve the protective gum arabic coating on the image surface of the plate and allow the metal to oxidize. An ink solvent is apt to cause the image to lose its affinity for ink. Pumice powder will scratch and grind the image and grain off the plate if it is not used carefully. Never use a sharp, pointed object or scraper of any kind to clean the plate, as it will cause low or high spots in the plate which create difficulties in printing.

(*d*) Wash hands thoroughly after using any of the cleaning materials to prevent skin irritation.

(2) Cleaning cylinder surfaces and bearers.

(*a*) Dirt on the cylinders, like dirt on the back of the plates, causes high spots which interfere with proper contact between the cylinders.

(*b*) Most of the foreign matter that accumulates on the cylinder is gum arabic and ink. Water will dissolve the gum arabic, and cleaning solvent will remove the ink.

(*c*) Remove rust with oil and crocus cloth. Keep a light film of oil on the cylinder and bearer surfaces at all times to prevent rust from recurring.

b. Packing Blanket and Plate Cylinders. In order to obtain good printing, a "squeeze" must be

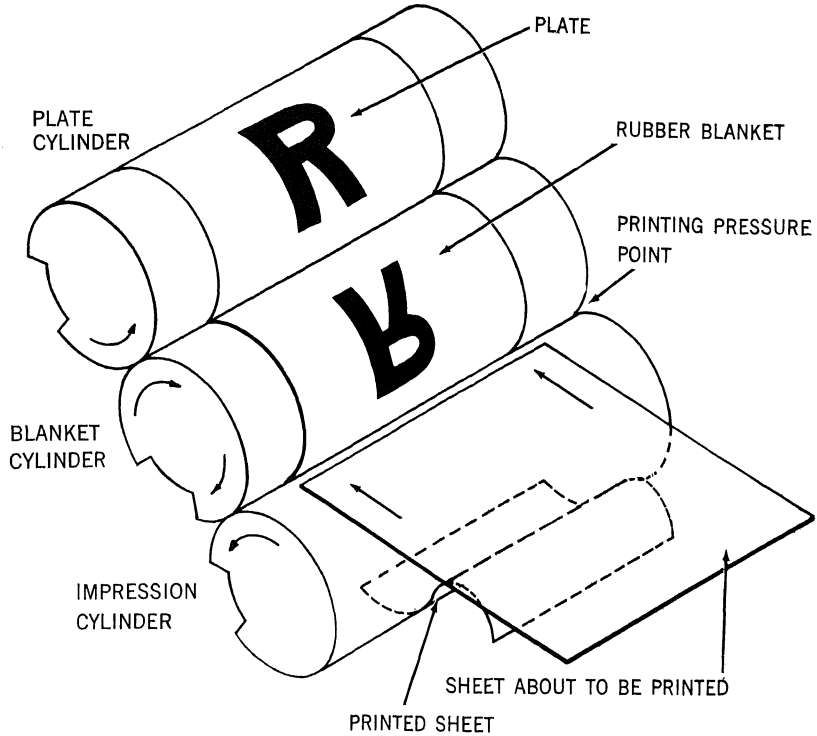


Figure 8-21. Cylinder assembly.

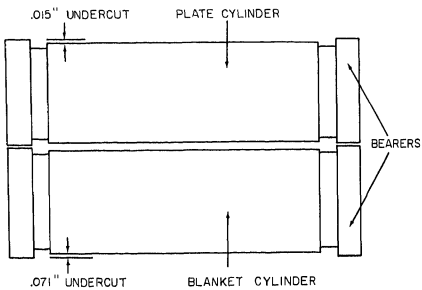


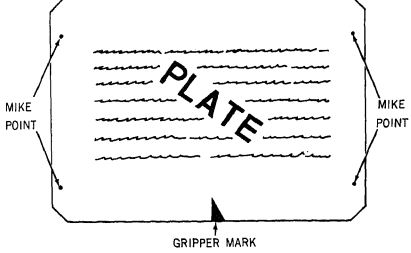
Figure 8-22. Cylinder undercuts.

developed between the plate and blanket cylinders (fig. 8-25). This squeeze is achieved by overpacking the cylinders slightly above their bearer diameters. The packing should total .003 inch more than the clearance between the cylinder bodies when their bearers are in contact. This overpacking is often referred to as .003 inch of pressure or 3 "points" of pressure.

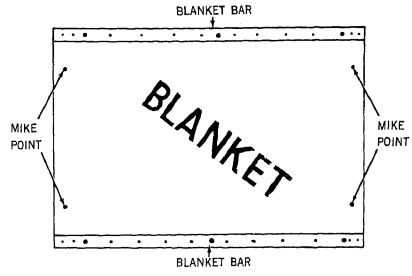
(1) *Cylinder undercuts.* Figure 8-22 illustrates the standard undercut on the plate and blanket cylinders on the ATF Model DP press.

(2) *Packing cylinders.*

(*a*) The packing of the cylinders shall be done only when the press is stopped and the switches are in the "safe" position. The blanket is underlayed with thin sheets of paper (packing) to raise it .002 inch above the blanket cylinder bearers. The plate is packed to .001 inch above the plate cylinder bearers. Since the bearers are in contact when the impression is "on," this obtains



"MIKING" THE PLATE



"MIKING" THE BLANKET

Figure 8–23. Recommended spots for measuring the thickness of plate and blanket with a micrometer (miking).

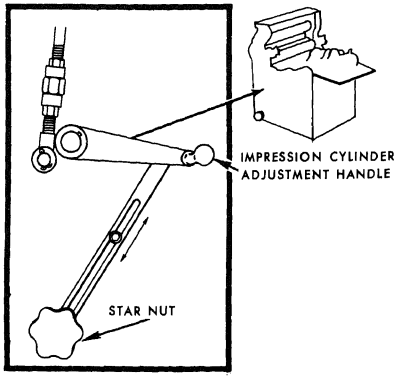


Figure 8–24. Impression cylinder adjustment handle—ATF Model DP.

the printing "squeeze" of .003 inch. Since the blanket cylinder has an undercut of .071 inch and is packed to .002 inch above its bearers, the blanket and packing together total .073 inch. The plate cylinder has an undercut of .015 inch and is packed to .001 inch above its bearers. The plate and packing together total .016 inch.

(*b*) A tolerance of .0015 inch is permitted when measuring the packing. This allows for the fact that blankets, plates, and packing do not always total the thickness desired. When faced with this problem, it is better to overpack within the tolerance.

(3) *Measuring thickness of blanket and plate.* Blanket and plate thicknesses vary; therefore, they must be measured with a micrometer before being mounted on the press. In order to assure accuracy and prevent errors owing to low spots, the blanket and plate are "miked" in several places and an average taken. The micrometer should not be placed at the gripper or tail edges of the blanket or plate, as the clamps and bars make the surfaces uneven and cause false readings. Also, the micrometer should not be pushed so far onto the material being measured that the material contacts the inside edge of the micrometer frame. This bends the material and causes a false reading (fig. 8–23).

c. Preparing and Mounting Blanket. The blanket on an offset press is changed far less frequently than the plate, but, since the plate cannot be mounted properly unless a blanket is on the blanket cylinder, this section on the preparation and mounting of blankets is presented before the section on plates.

(1) *Putting clamps or bars on new blanket.* When clamping a new blanket, several precautions must be taken to produce the desired result.

(*a*) Scrub the new blanket thoroughly with pumice powder and cleaning solvent to remove the slight glaze caused by oxidation of the rubber.

(*b*) If the blanket has not been punched, place a blanket bar, or clamp, across one end of the blanket at right angles to the direction of the arrow on the canvas side of the blanket. Aline the blanket bar evenly with the edge of the blanket. Insert a pencil into each hole in the blanket. The pencil marks will then correspond exactly with the holes in the blanket bar. Follow the same procedure on the other end of the blanket. Make certain that the second bar is parallel to the first. Then remove the blanket bars and punch in or cut out all of the indicated holes. Cut the holes cleanly

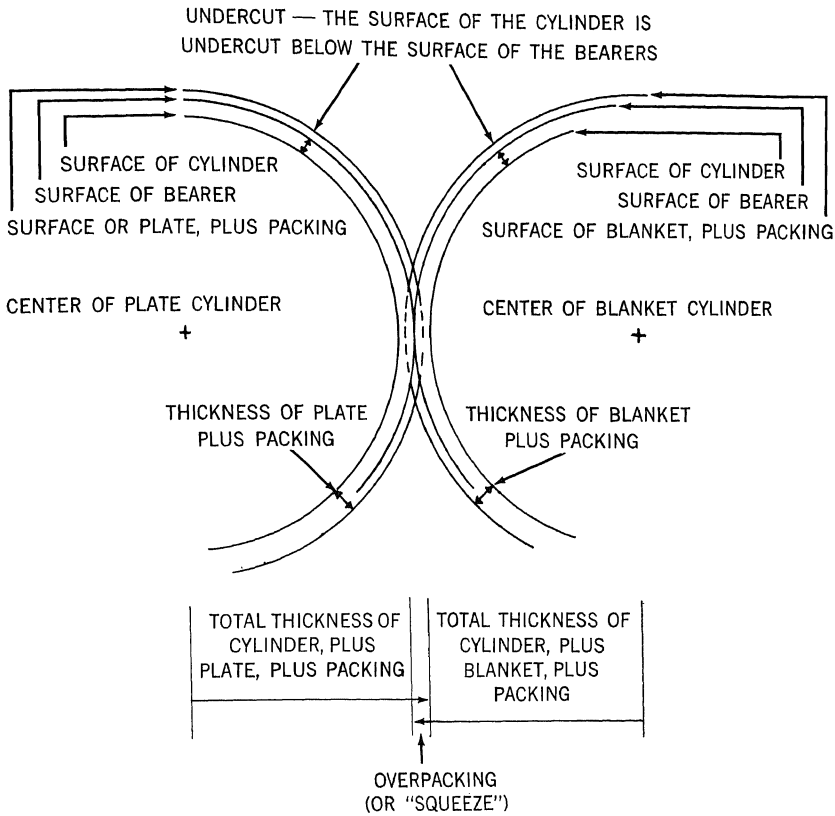


Figure 8–25. Overpacking plate cylinder and blanket cylinder.

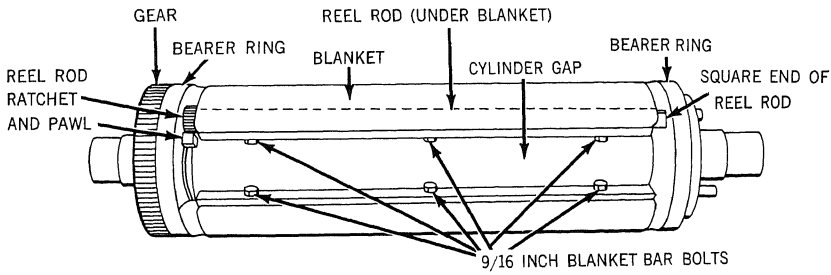


Figure 8–26. Blanket cylinder assembly.

because irregular fragments of rubber may cause the blanket bar bolts to bind. Attach the bars to the blanket.

(2) *Mounting blanket* (fig. 8–26).

(*a*) Before working on the blanket or plate, remove the cylinder guard. This guard, of course, is never removed until the operator has assured himself that the safe switches are turned to "safe," disconnecting all power from the press. As long as this guard remains off, the cylinders can be moved only by turning the flywheel manually. Power must *never* be used while mounting a blanket or plate.

(*b*) The blanket is first "miked." Check several points, not near the blanket bars, and take an average. Select sufficient paper packing to total .073 inch when added to the thickness of the blanket.

(*c*) Place one blanket bar on the lower surface of the gap in the blanket cylinder. Pass three 9/16 inch bolts through the holes in the blanket bar and into the threaded holes in the cylinder gap, and tighten the blanket bar to the cylinder. Do not force these bolts. If they do not turn freely, it may be because they are binding on rubber. If they are, the holes in the blanket must be cut larger. Care must be taken to start the bolts properly in the threaded holes, or misthreading will result.

(*d*) Turn the cylinder slightly forward by hand, until it is possible to insert the packing sheets behind the blanket. Then turn the cylinder forward three quarters of a revolution until the blanket covers the blanket cylinder and the free-blanket bar is at the top of the cylinder gap.

(*e*) Attach the free-blanket bar to the reel rod with the three remaining 9/16 inch bolts. Take special care to prevent misthreading these bolts. It is best to start the center bolt first.

(*f*) Place a 1-inch wrench on the square end (operator's side) of the reel rod. A pawl and ratchet at the other end of the reel rod will hold the blanket tight. Engage the pawl into the ratchet and pull the wrench to tighten the blanket around the cylinder. Use only the pressure and leverage of the hands on the wrench when tightening the blanket. Never use a wrench longer than the one furnished with the press.

(*g*) The tautness of the blanket can be determined by tapping the surface of the blanket between the reel rod and the tail edge of the blanket cylinder with the finger or some object that will not cut or otherwise injure the blanket surface.

(*h*) When removing the blanket, first release the tension from the reel rod. Then remove the three bolts locking the blanket bar to the reel rod and turn the cylinder backwards *by hand* until the blanket is off the cylinder. Remove the three bolts locking the other blanket bar and the blanket from the cylinder. Dispose of the paper packing if it has become wrinkled or sticky.

d. Preparing and Mounting Plate (fig. 8–27)

(1) Before working on the plate, remove the cylinder guard. This guard, of course, is never removed until the operator has assured himself that the safe switches are turned to "safe," disconnecting all power from the press. As long as this guard remains off, the cylinders can be moved only by turning the flywheel manually. Power must *never* be used while mounting a plate.

(2) The plate must be "miked" before mounting. Check several points, not near the clamp edges, and take an average. Select enough paper packing to total .016 inch when added to the thickness of the plate. For instance, one brand of commercial, presensitized plate averages .006 inch thick which means that approximately .010 inch of paper packing must be inserted under this type of plate.

(3) Loosen the plate clamps by turning the quoin keys counterclockwise and back off the tension screws. This permits a maximum amount of adjustment when subsequently tightening the plate around the cylinder.

(4) With the image side of the plate out, insert the gripper edge of the plate as far as possible into the top plate clamp. If the plate is not inserted into the clamp the full distance, it is apt to go around the cylinder crooked and pull out of the clamp when it is being tightened. Center the plate in the top plate clamp by lining up the gripper center mark on the plate with the scribed centerline on the plate clamp. If the top plate clamp does not have a scribed center line, center the plate in the clamp by alining the right (operator's side) edge of the plate with the right edge of the cylinder surface. When the plate is centered, tighten the top clamp. Make certain that the clamp is flush with the top of the cylinder gap. If the top plate clamp is not perfectly alined with the gap, the plate will not tighten evenly around the cylinder.

(5) In order to position the plate around the cylinder properly, the impression must be "on". To do this, throw the ink motion throw-off handle into its "lockup" position, as shown in figure 8–28. The handle must be pulled toward the operator's

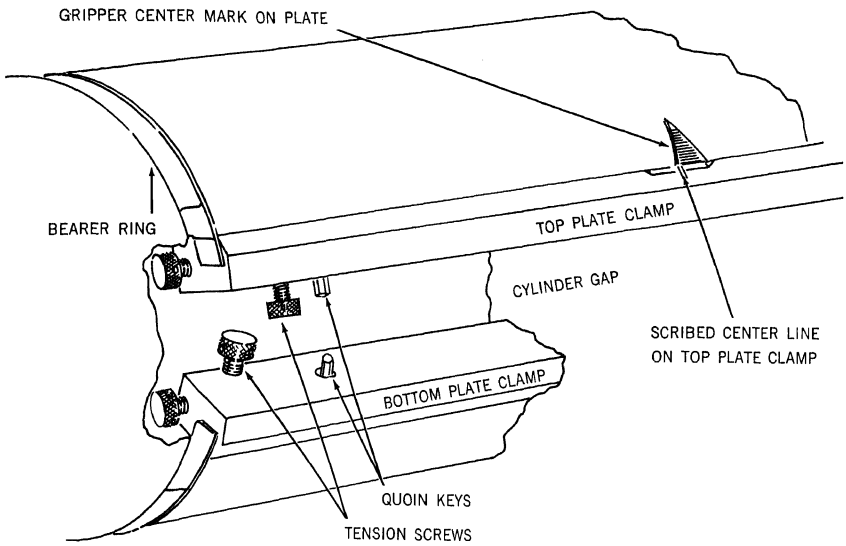


Figure 8–27. Mounting plate on plate cylinder.

side and turned a one-half turn to stay in the lock-up position. This prevents the ink rollers from dropping onto the plate cylinder when the impression is "on." Then place a small strip of paper under the automatic trip (fig. 8–29) to prevent the press from coming off impression while the plate is being mounted. Now press the impression throw-on lever down. This lever is located directly above the feeder valve (fig. 8–13). This causes the impression to be "on" as the press is turned forward; i.e., the impression linkage arm will straighten out and cause the blanket cylinder to move into contact with the plate and impression cylinder. The blanket cylinder must have a blanket mounted on it before the plate can be properly mounted on the plate cylinder. To insure that the press is on "impression" when the plate starts between the cylinders, push down on the impression linkage arm, which causes it to straighten out, before turning the flywheel.

(6) Next, turn the press forward by hand until the plate starts between its own cylinder and the blanket cylinder. Place the correct amount of packing behind the plate, and again turn the press forward by hand until the plate covers the plate cylinder.

(7) Insert the trailing edge of the plate into the bottom plate clamp, and tighten the clamp.

(8) Take the slack out of the plate by tightening the tension screws (fig. 8–27). Do not overtighten these screws or the plate will be stretched and torn or pulled out of the plate clamps. When a crease begins to appear in the plate at the points where it passes over the cylinder gap, tap the plate gently with a wrench. If the plate is tightened sufficiently, the resulting sound will seem to come from a solid object.

(9) Push either of the manual impression trips, remove the strip of paper from under the automatic trip, and turn the press forward one revolution to take the impression "off." Tear away any excess packing extending past the plate.

(10) When removing the plate, free the tail edge from the bottom clamp first, and turn the press backward by hand until the plate is off the cylinder. Then loosen the plate clamps on the gripper edge and remove the plate from the press.

(11) Flatten the creases in the plate with a plate roller and either place the plate in storage or send it to be grained.

(12) After work on the blanket and plate has been completed, replace the cylinder guard.

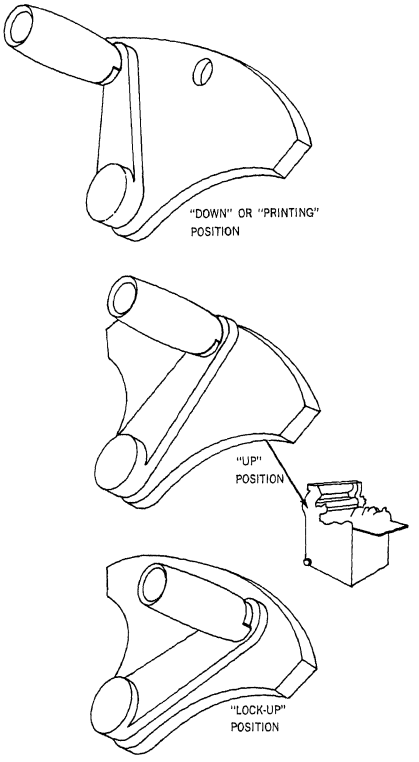


Figure 8–28. Ink motion throw-off handle on ATF Model DP.

e. Adjusting Impression Cylinder.

(1) There are no bearers on the impression cylinder, which means the cylinder can be moved into proper contact with the blanket cylinder when using different weights of stock or when the blanket is packed below the height of the blanket cylinder bearers.

(2) To permit the correct .003 inch "printing pressure" when printing on various thicknesses of stock and to allow for various heights of blanket and packing, the impression cylinder is provided with an eccentric movement. This movement is controlled by the impression cylinder adjustment handle (fig. 8–24) located on the operator's side of the press behind the automatic pile receder. To increase the pressure between the impression cylinder and the blanket cylinder, loosen the starnut and move the impression cylinder adjustment handle down. To lessen the pressure between the two cylinders, pull the handle up. An adjustment of 1/8 inch in the position of the handle means an increase or decrease of .001 inch "pressure" between the two cylinders. This adjustment should be made just tight enough to print solid and no more. Extra pressure can cause wrinkles, slurs, and other problems.

f. Impression. The three cylinders do not contact each other unless the press is "on impression." When the press is running and the impression throw-on lever is depressed, the impression linkage arm will straighten out and cause the blanket cylinder to move on an eccentric until its bearers contact the plate cylinder bearers and (assuming the impression cylinder adjustment handle is not pulled all the way up) the blanket surface contacts the surface of the impression cylinder. It is in this position *only* that the image from an inked plate transfers to the blanket and, in turn, to the paper.

(1) *Impression trips.* Any offset press is equipped with trips which, when activated, cause the blanket cylinder to move on its eccentric away from the plate and impression cylinder (i.e., to trip "off impression").

(*a*) *Manual trips.* The AFT Model DP press is equipped with two manual trips, one located on the operator's side and the other located at the delivery end of the press on the gear side. These need only to be pushed or depressed to activate the "off impression" trip mechanism.

(*b*) *Automatic trip.* The ATF Model DP press is equipped with an automatic trip located at the center of the conveyor board near the side guide bar (fig. 8–29). Should a sheet fail to reach the finger on the automatic trip at the prescribed time, the finger will engage the "off impression" mechanism beneath the conveyor board.

(2) *Counter.* The counter is an automatic device for keeping track of the quantity of stock being run. There is no way that the counter can record the number of printed sheets that actually reach the delivery pile. The counter records only while the press is "on impression."

g. Register Adjustments of Plate Cylinder. When the first sheets are printed during makeready, it is often found that the image is not properly positioned in relation to the gripper edge of the sheet. Two adjustments of the plate or plate

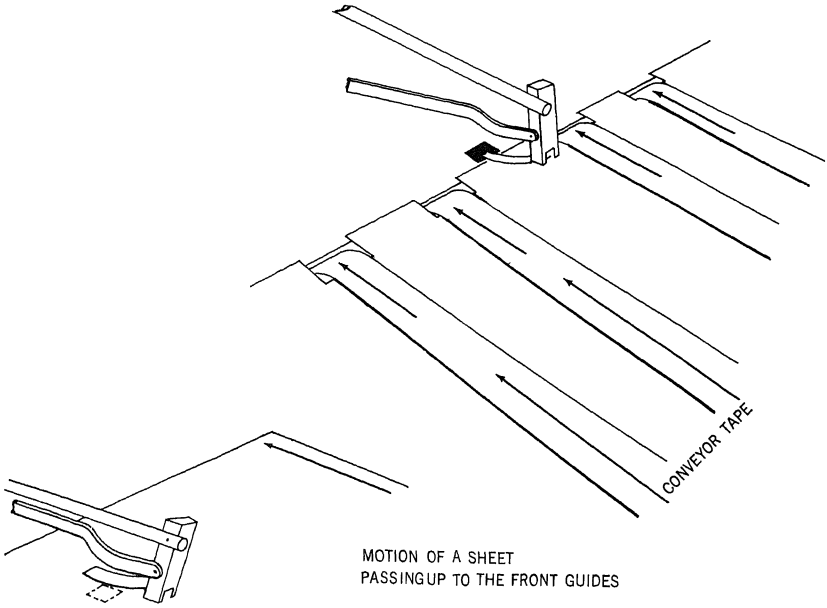


Figure 8-29. Automatic trip mechanism.

cylinder usually correct this. These adjustments shall be made only with the cylinder guard removed and the switches in the "safe" position.

(1) *Twisting plate.*

(*a*) If the image is slightly crooked in relation to the gripper edge of the sheet, twist the plate to a new position on the plate cylinder.

(*b*) It is not feasible to try to list all possible adjustments for this operation. The following is only one example of the type to plate-twisting adjustment which may be made on the ATF Model DP press.

(*c*) Suppose it has been decided, after a printed sheet has been checked, that the image from the plate being run needs to be brought 1/16 inch closer to the gripper edge margin on the right side. To do this, loosen the three tension screws on the bottom plate clamp. Mark a line on the plate and another line on the plate cylinder 1/16 inch ahead, in the direction of the cylinder gap (fig. 8-30). Then start tightening the tension screw in the corner of the top plate clamp. Also tighten the center tension screw to a lesser degree. When the line on the plate slides forward and is alined with the mark on the cylinder, the plate has been twisted properly.

(*d*) The maximum amount that the plate can be twisted is approximately 1/8 inch. Further twisting can tear the plate or pull it out of the plate clamps.

(*e*) When the plate has been twisted to the desired position, any slack remaining in the plate can be removed by tightening the tension screws. Finally, the old image must be washed from the blanket.

(2) *Swinging plate cylinder.* If the image is parallel with, but too close to or too far from the gripper edge of the sheet, the plate cylinder may be swung to a different position in relation to the blanket cylinder. Swinging the cylinder up causes the image to print farther from the gripper edge of the sheet, providing more margin. Swinging the cylinder down causes the image to print closer to the gripper edge of the sheet with less margin. The amount of swing can be controlled by alining a mark on the plate cylinder bearer with a plate cylinder gear tooth and observing the distance be-

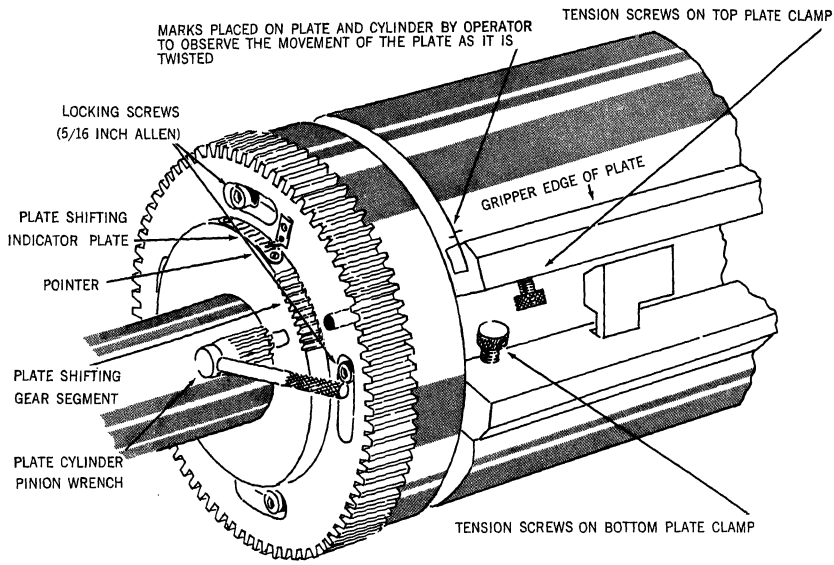


Figure 8–30. Adjustments for twisting and swinging plate.

tween the two points as the cylinder is swung. The maximum amount of plate cylinder swing is 1½ inches (¾ in. either way from the center point). To adjust the ATF Model DP, free the cylinder from its gear segment by loosening the four locking screws on the gear side of the cylinder (fig. 8–30). Loosen the locking screw adjacent to the plate shifting gear segment last so the plate will not slip. Insert the plate cylinder pinion wrench and engage it with the gear segment. Next, swing the plate cylinder to the desired position. Then, tighten the four locking screws and wash the old image from the blanket. Finally replace the cylinder guard.

Section VI. DAMPENING ASSEMBLY

8–17. Introduction

The dampening assembly is a device for evenly moistening the plate with a special dampening solution as the plate cylinder revolves. This action precedes the inking of the plate. The dampening solution, which clings to the nonprinting areas of the plate, prevents the ink from adhering to any portions of the plate except those which are to be reproduced. This assembly consists of metal and cloth-covered rollers arranged in such a manner that the dampening solution is easily picked up and properly distributed and the plate is moistened evenly. See figure 8–31 for a simplified diagram of the dampening assembly.

8–18. Nomenclature Pertaining to Dampening Assembly

Part	Function
Water pan	Used to hold the fountain solution which is to be distributed through the dampening assembly rollers to the plate (fig. 8–31).
Fountain solution	A slightly acid liquid, mostly water, used to dampen the nonprinting areas of the plate so that they will repel the greasy ink when the plate is inked (fig. 8–31).

Part	Function
Fountain roller	As it revolves, it picks up the fountain solution and transfers it to the dampener ductor roller during the period the ductor is in contact with the fountain roller (fig. 8–31).
Dampener ductor roller.	Conveys the fountain solution from the fountain roller to the rest of the dampening assembly rollers by being in contact with the fountain roller part of the time and touching the dampener vibrator roller the remainder of the time (fig. 8–31).
Dampener vibrator roller.	Picks up the fountain solution from the dampener ductor roller and distributes it evenly to the dampener form rollers. It moves from side to side along its axis as it rotates (approx ⅝ in.) (fig. 8–31).
Dampener form rollers.	Transfers the dampening, or fountain, solution from the vibrator roller to the plate (fig. 8–31).
Water motion throwoff handle and latch.	Controls the motion of the whole dampening assembly to or away from the plate cylinder (fig. 8–32).
Water-on lever	Controls the movement of the dampener ductor roller (fig. 8–33).
Water motion control.	Governs the length of time the dampener ductor roller remains in contact with the fountain roller (fig. 8–34).
Water stops	Used to control, in a very limited area, the amount of fountain solution on the fountain roller (not illustrated).
Drip pan	Used to catch any fountain solution which may drip out of the water pan (not illustrated).

8–19. Operational Instructions

a. Positioning Entire Dampening Assembly by Means of Different Settings for Water Motion Throwoff Handle and Latch. The main control for the dampening assembly is the handle and latch mechanism which moves the whole assembly to or from the plate. The three operating positions for the water motion throwoff handle and latch are illustrated in figure 8–32.

(1) In position 1, the dampening assembly is engaged, with the form rollers against the plate. This is the operating position which is used any time the ink rollers are against the plate, as when printing. This position is identified by the handle being in the top slot of the latch.

(2) In position 2, the assembly is engaged (gears are meshing), but the form rollers do not touch the plate. This position is used when wetting the assembly, idling with gum on the plate, and at various other times when the ink rollers are not in contact with the plate. This position is identified by the handle being in the bottom slot of the latch.

(3) In position 3, the entire assembly is racked back as far as it will go, thus disengaging the gears completely. This position is used when the dampening assembly is not being used, such as when the press is being cleaned or adjusted.

b. Explaining Action of Water-On Lever. In order to control the solution transfer from the fountain roller to the other rollers in the assembly, the ductor roller motion is controlled in two ways. One of these controls is the water-on lever. This lever, located just below the side guide mechanism and directly above the feeder valve, on the operator's side, controls the movement of the ductor roller (fig. 8–33).

(1) When the lever is in its "on" position (down), the ductor roller moves back and forth in an arc between the vibrator and the fountain roller, receiving and delivering solution while the press is running.

(2) When the lever is in the "off" position (up), the ductor roller ceases its arcing motion and simply rolls in contact with the vibrator roller, and therefore does not receive or deliver any additional solution.

(3) It is evident why such a control is necessary. When the press is idling and the fabric rollers are sufficiently damp, no more solution need be delivered. While the press is printing, the ductor roller must deliver solution to the form rollers to replenish that lost by evaporation, transfer to the plate, and to the stock. However, when the press is not printing, no solution is being used, and the solution flow must be stopped or an excess will be built up in the dampener rollers.

c. Setting Water Motion Control Unit. The second control for the ductor is the water motion control, which governs the length of time the ductor roller remains in contact with the fountain roller. This control is located on the gear side of the press just below the dampening assembly drive gears (fig. 8–34).

(1) By means of an adjustable cam, this de-

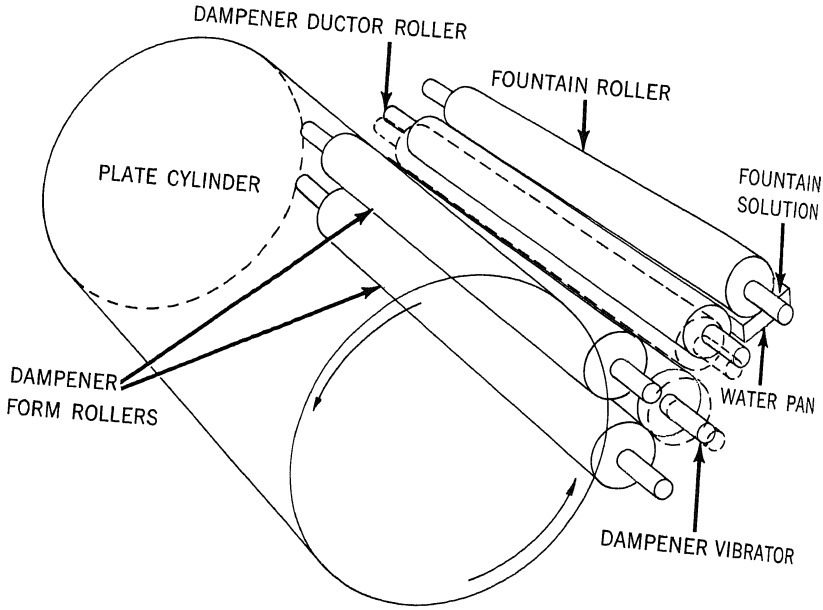


Figure 8-31. Dampening assembly.

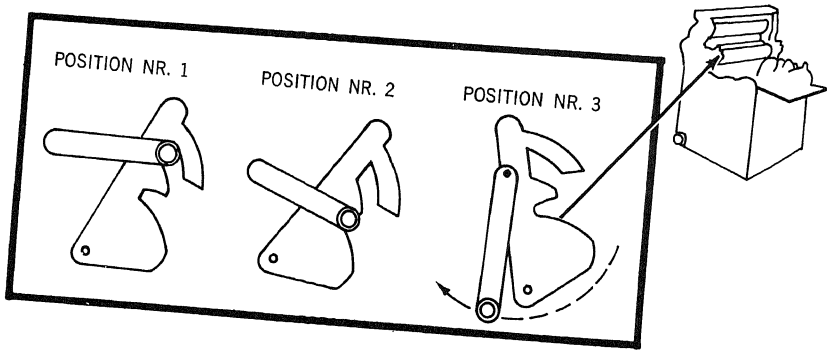


Figure 8-32. Three positions of water motion throwoff handle and latch.

ice controls the period that the ductor contacts the ountain roller, and therefore the amount of solu- on received by the form rollers. The cam (or a ortion of it, depending on the press model), which activates the ductor roller's arcing motion, can be raised or lowered by means of this control. Raising this cam causes the ductor roller to remain (dwell) against the fountain roller for a

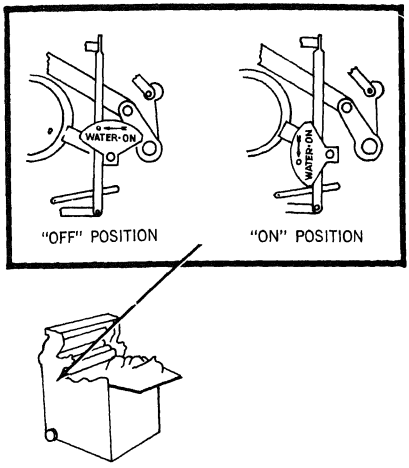


Figure 8-33. Positions of water-on lever.

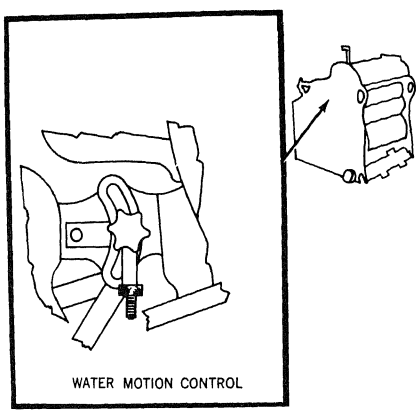


Figure 8-34. Water motion control unit.

longer period of time, thus receiving and delivering more solution. Lowering the cam decreases the amount of solution.

(2) The control unit consists of a bar, a short metal arm, a star-shaped locking wheel, and a knurled thumbscrew. Loosening the locking wheel and turning the knurled knob moves the bar along an arc. Moving the bar up causes the cam to drop down, decreasing the "dwell" and the amount of solution. Moving the bar down causes the cam to rise, increasing the "dwell" and the amount of solution.

d. Adjusting Dampening Assembly Rollers.

(1) *General theory of setting.*

(*a*) *Introduction.* For the dampening assembly to do its necessary job, each component must be correctly adjusted. Fabric-covered rollers cannot hold constant diameters with shrinkage and wear of the fabric, and so must be constantly adjusted to give the best possible transfer of solution from one roller to another. An incorrectly set assembly can cause many troubles during a press run. Dry streaks resulting in scum, and wet streaks resulting in loss of color are two of the many possible troubles. The only roller in the dampening assembly that is not adjustable is the vibrator roller. This roller is permanently set in the unit and as such is always parallel to the plate cylinder. For this reason, it is often called the base roller. All of the other rollers are set to or from the vibrator roller, directly or indirectly. The theory of roller setting should be thoroughly understood by each operator before he attempts to make any adjustments himself.

(*b*) *Use of strips of paper or acetate as feelers.* To check the pressure of one roller to another, strips of paper or acetate, .003 to .004 inch thick, are used as feeler gages. The strips are placed between the rollers to be adjusted and then withdrawn. The pressure or "drag" on the strips is indicative of the pressure between the rollers. The rollers are adjusted to get a light, even tension on the strips when they are pulled. It is very important that the tension be equal on both ends of the rollers and that low or high spots be compensated for.

(*d*) *Dampening assembly roller adjustment.* There are only two basic types of dampening assembly roller adjustments—adjustment to the vibrator roller and adjustment to the plate cylinder (fig. 8-35).

1. Adjustment to vibrator roller. As was mentioned previously, the vibrator itself is not adjustable and is permanently set in the unit. It is always parallel to the plate cylinder. The two dampener form rollers are set to it or from it, directly or indirectly. Any adjustment made between the vibrator roller and an adjacent roller causes the center points on the axis of each roller to move either toward or away from each other, establishing the pressure between these rollers at adjustment point A. Theoretically, once the pressure ad-

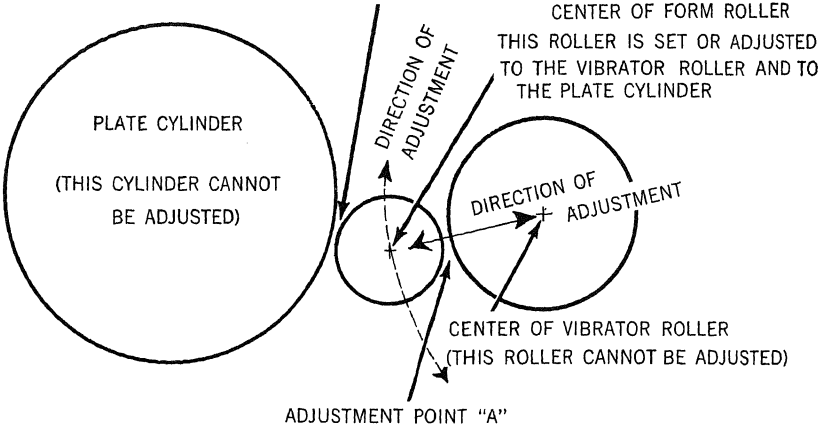


Figure 8–35. Two basic types of roller adjustments.

justment to the vibrator roller has been made, subsequent adjustments (i.e., adjustments to the plate cylinder) should not affect the pressure at adjustment point A, since the distance between the midpoint of the axis of the vibrator roller and the form roller should not change.

2. Adjustment to plate cylinder. The other adjustment is used to set the roller to the plate cylinder. This adjustment establishes the correct pressure at adjustment point B in figure 8–35. This adjustment moves the form roller in an arc around the vibrator roller and theoretically should not affect the pressure adjustment already made to it.

(2) *Setting dampener form rollers.*

(*a*) *General considerations.*

1. In spite of the theory mentioned above, the adjustment to the plate cylinder usually affects the adjustment previously made to the vibrator roller. For this reason, constantly check and recheck the adjustments until they become so slight that the adjustment to the plate has a negligible effect upon the adjustment to the vibrator roller. Make certain that the final adjustment is an adjustment to the plate cylinder.

2. Another complicating consideration is that a roller must be set evenly along its entire length, rather than at one point or in cross section as shown in figure 8–35. This necessitates a preliminary or paralleling adjustment to insure that the roller is not canted when it is set to the base roller. This is an adjustment to the plate cylinder. A roller that is canted can be set so that the "drag" on the feeler strips is the same at both ends, but the pressure near the center of the roller will be excessive and will strain the rollers, and might damage the adjustment mechanism.

3. The rule is to begin setting with the adjustment to the plate (to parallel), then alternate from adjustment to the vibrator to adjustment to the plate, making a finer adjustment each time. The last adjustment must be to the plate cylinder.

(*b*) *Adjusting the top form roller.* The top form roller is set first. It is placed in the top brackets and secured by holddowns (if that particular press is equipped with them).

1. Setting to the vibrator. Feeler strips are inserted between the form roller and the vibrator roller approximately 2 inches in from each end of the roller. Adjustments are made to the vibrator roller by using the screw marked B (fig. 8–36). Turning the screw clockwise decreases the pressure between the vibrator roller and the form roller. Turning the screw counterclockwise increases the pressure between the vibrator roller and the form roller.

2. Setting to the plate. Feeler strips are inserted between the form roller and the plate cylinder approximately 2 inches from each end of the

roller. The dampening assembly is moved to the number 1 position (fig. 8–32) by using the water motion throw-off handle. Adjustments are made to the plate cylinder by using the square-headed bolts marked D (fig. 8–36). Turning the bolts clockwise decreases the pressure to the plate cylinder while turning counterclockwise increases the pressure between the form roller to the plate.

3. The top form roller is removed to insure accurate adjustment.

(*c*) *Adjusting the bottom form roller.* The bottom form roller is placed in its brackets and secured by the holddowns. It is set exactly in the same manner as the top form roller.

1. Setting to the vibrator. Feeler strips are inserted between the form rollers and the vibrator roller approximately 2 inches from each end of the roller. Adjustments are made to the vibrator roller with the screw A (fig. 8–37). The adjustment is turned clockwise to decrease the pressure and counterclockwise to increase the pressure between the form roller and the vibrator roller.

2. Setting to the plate. The dampening assembly is moved into the Number 1 position (fig. 8–32), by using the water motion throw-off handle. Feeler strips are inserted between the form roller and the plate cylinder approximately two inches from each end of the roller. Adjustments are made to the plate cylinder by turning the square headed bolts C (fig. 8–37). Turning the bolts clockwise decreases the pressure to the plate cylinder while turning counterclockwise increases the pressure between the form and the plate.

(3) *Setting fountain roller.* The next roller to be adjusted is the fountain roller. Turn the press until the ductor roller activating mechanism is on the high point of its activating cam (ductor roller against the fountain roller when the water-on lever is "on"). Then set the fountain roller to properly contact the ductor roller. The paper feeler strips may be positioned easily by raising the water-on lever, inserting the strips and then dropping the water-on lever to its original "on" position. Make the adjustment by loosening the hexagonal bolts on the fountain roller brackets, F (fig. 8–39), moving the brackets by hand until the fountain roller is parallel to the ductor roller, and then retightening the bolts. The bracket on the gear side of the fountain roller can be moved very little because of the binding action of the fountain roller driving gear. Thus, the only practical adjustment for the fountain roller is the bracket on the

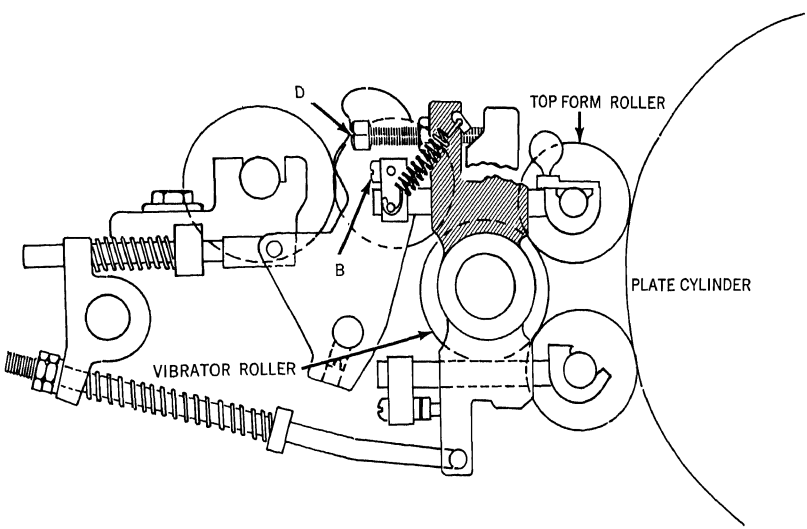


Figure 8–36. Setting and adjusting top form roller (dampening assembly).

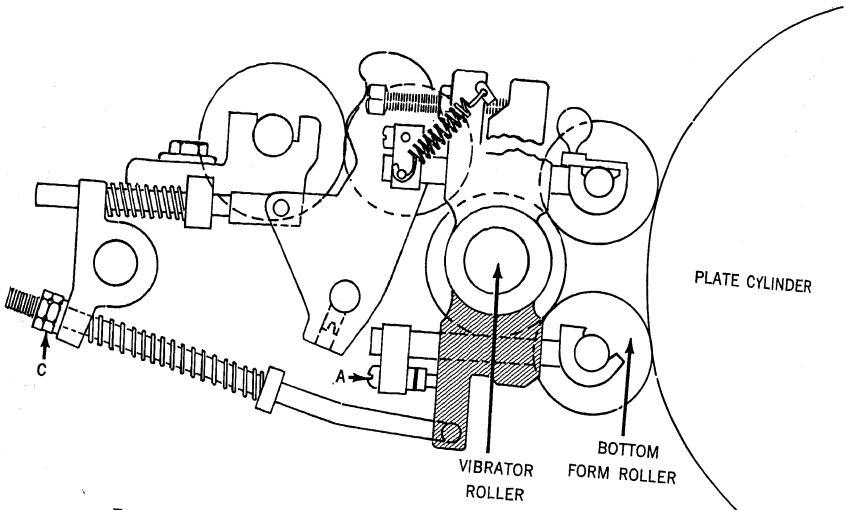


Figure 8–37. Setting and adjusting bottom form roller (dampening assembly).

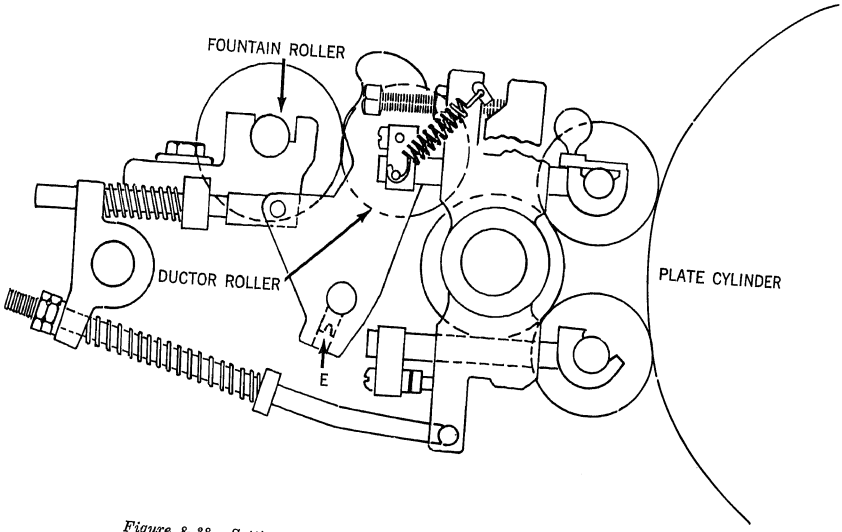


Figure 8–38. Setting and adjusting ductor roller (dampening assembly).

operator's side. This adjustment is used only to parallel the fountain roller to the ductor roller. If the pressure is incorrect, the adjustment described in the following paragraph must be made.

(4) *Setting ductor roller.*

(*a*) The next roller to be adjusted is the ductor roller. It is set to the vibrator roller. It must be set while its activating mechanism is on the low point of its activating cam (rolling against the vibrator roller when the water-on lever is "on"). The ductor roller may be lifted up slightly to insert the paper feeler strips. Make the adjustment by loosening the allen setscrew E (fig. 8–38) in the roller bracket *on the operator's side,* moving that bracket by hand so that the ductor roller is parallel to the vibrator roller, and then retightening the allen setscrew. Note that the allen setscrew is only a lock, and that the actual adjustment is made by hand.

(*b*) *Important!* Although there are allen setscrews on both brackets, *loosen only the bracket on the operator's side* to make the adjustment, since loosening the gear side bracket allows the entire mechanism which activates the ductor roller to slip out of adjustment. *The gear side bracket shall be loosened only by a press erector or senior pressman.*

(*c*) Note, also, that this adjustment is used only to parallel the ductor roller to the vibrator roller and not to adjust the pressure. *If the pressure is excessive, tight, or loose, a press erector or senior pressman makes the adjustment.* (This adjustment consists of turning the press by hand until the ductor roller activating cam is at its lowest point, loosening the allen setscrews in both brackets, adjusting the ductor roller manually until it has sufficient pressure against the vibrator roller across its entire length, and retightening both allen setscrews. This usually necessitates readjusting the ductor roller to the fountain roller as described in (5) below.)

(5) *Setting ductor roller to fountain roller.* In rare instances, the ductor roller will have improper pressure against the fountain roller, despite the fact that the fountain roller is forward to the limit of its adjustment. This can be corrected by using the adjustment on the gear side of the assembly. This adjustment regulates the degree to which the ductor roller shaft will be turned by its activating cam. *Such an adjustment shall be made only by a press erector or senior pressman.*

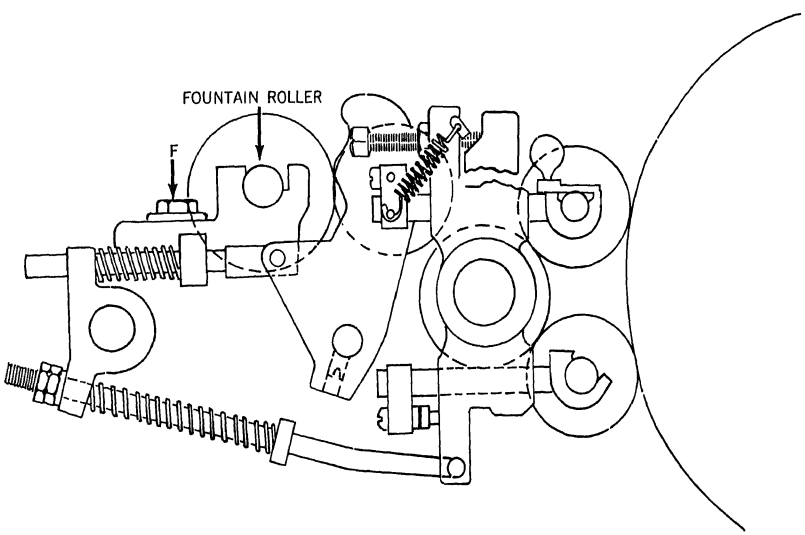


Figure 8–39. Setting and adjusting the fountain roller.

8–20. Fountain Solution and pH Control

a. Reason for Special Fountain Solution. The fountain solution has been defined functionally in the nomenclature paragraph at the beginning of this section as a slightly acid liquid, mostly water, used to dampen the nonprinting areas of the plate so that they will repel the greasy ink when the plate is inked. This mutual repulsion of ink and water is the underlying principle of lithography. Plain water, however, is not adequate for the practical application of the principle, so fountain solution has been developed. Water alone tends to swell and break down the image on the plate and also tends to emulsify the ink. Fountain solution, when properly prepared, keeps the plate from accepting ink in the nonprinting areas and at the same time preserves the image for a maximum number of impressions. Proper acidity of the solution used reduces the image swelling and the tendency for ink to emulsify. Too much acid attacks the grain on the plate and undermines the image. When grained plates are used, acid reduces the size of the grain which holds the solution.

b. Fountain Solution Formula. Commercially prepared fountain solution may be used if available. The following formula, used at the U.S. Army Engineer School, should be used if the commercial solution is not available:

Plate etch—½ oz (see app C for the formula for plate etch).
Gum arabic—½ oz (see app C for the formula for gum arabic).
Water to make—1 gal.

c. Acidity of Fountain Solution. pH Values.

(1) The fountain solution should have a certain amount of acid in its makeup. The amount of acid and the effect of varying amounts of acid are important. Plain water has proven unsatisfactory because of resulting problems with scumming of the plate, emulsification of the ink, and weakening of the image itself. The addition of a proper amount of acid reduces these difficulties; however, too much acid causes other troubles.

(2) Too much acid tends to attack the plate in two ways. First, the diazo image is undermined, resulting eventually in a partial or complete loss of the printing areas. Second, the grain, if the plate has a mechanically grained surface, is worn down much more rapidly than usual, and an overall sensitizing of the nonprinting areas occurs. This eventually causes background tinting. Thus, it is obvious that some method of determining acidity and keeping it constant is necessary. A method developed by chemists and simplified for everyday use gives the acid content a numerical value preceded by the symbol pH, which means "potential Hydrogen."

(3) The pH value is a measure of the degree of acidity or alkalinity of a solution. It is expressed in numbers ranging from 0 to 14, a pH of 7 representing a neutral solution (for example, chemically pure water). As the pH increases above 7, the alkalinity increases; as it decreases below 7, the acidity increases. Therefore, a pH of 0 represents the strongest possible acid and a pH of 14 represents the strongest possible alkali. The proper pH for fountain solution to be used with aluminum plates is 4.6.

(4) There are several ways of determining the actual pH of a given solution, so that any required additions of either acid or alkali can be made to bring it to the optimum of 4.6.

(*a*) For everyday and field use, the most reliable and simplest instrument to use is the pocket comparator, which is a colorimetric method. In practice, a measured portion of the fluid to be tested is poured into a vial. A measured portion of a chemical indicator or dye is then added from a graduated dropper. The resultant colored solution is then placed in the comparator and is color matched to one of several standard colors. The pH of the solution can then be read from a dial. This method is not so accurate as the electrometric method, but is much simpler and handier.

(*b*) Another colorimetric method, even faster and simpler than that above, is available, but is not accurate, and gives only an approximate pH value. It is a strip of paper which changes color when brought into contact with acid or alkaline solutions. It is essentially a litmus paper. One brand, called Alkacid Test Ribbon, is immersed in the solution to be tested until it changes color. Its color is then compared to a standard color chart.

(*c*) If the fountain solution were mixed and found to have a value of 3.0, it would be necessary to add water until the pH changed to 4.6. Likewise, if the pH value were 4.8, a little more acid (phosphoric acid) would be added.

(*d*) Difficulties may arise in mixing the component ingredients of the fountain solution to exactly the same strength. The formula for fountain solution may have to be changed to suit the circumstances. For example, if a new batch of plate etch gives a pH value of 3.2 when the regular formula for fountain solution is used, the pH

should be adjusted by the addition of water and less acid used the next time the plate etch is mixed.

8–21. Care and Cleaning of Dampening Asssembly Rollers

a. Cleaning Metal Rollers.

(1) Many troubles in printing with the lithographic press arise from dirty rollers in the dampening assembly. When the metal rollers in the assembly become coated with ink, they cannot carry the dampening fluid properly. This often causes dry streaks on the plate, resulting, in turn, in scumming. Oxidation of the metal surfaces can also prevent the rollers from carrying the fountain solution properly.

(2) To clean rollers that have picked up ink on their surfaces, remove the fabric covered rollers from the assembly. Clean off the ink with an ink solvent. Then scrub the metal surfaces thoroughly with a mixture of plate etch and pumice powder to increase their affinity for the fountain solution.

(3) To clean rollers that have oxidized, the last step used in (2) above is employed. Sufficient rubbing with pumice powder will take care of even the most serious oxidation. Alternately, a good grade of metal polish, followed by washing with plate etch, will do the job very well.

(4) Once the metal rollers have been cleaned, it is good practice to apply a thin coat of gum arabic. This coating serves to prevent oxidation. At least one cleaning and one coating of gum arabic per day should be standard procedure when operating the press.

b. Cleaning Fabric Covered Rollers.

(1) Just as dirty metal rollers will not carry the fountain solution properly, the fabric-covered rollers also will not carry solution when the fabric is saturated with ink or grease. This condition is more serious with the fabric covered rollers than with the metal rollers because the ink not only prevents the transfer of dampening fluid, but also tends to be redeposited on the plate. The tendency to scum is therefore much greater if the rollers are dirty.

(2) The fabric-covered rollers may be cleaned in several ways, the most common being with a stiff-bristled brush and plain water. If the rollers are extremely dirty, soap or one of several commercial cleaning preparations may be used. Care should be taken to rinse the rollers thoroughly. Occasionally, an ink solvent may be employed to help remove the ink, again rinsing thoroughly to remove all traces of the solvent. Following any scrubbing, the rollers must be scraped with the edge of an ink knife to remove any excess water and loosened dirt.

(3) The rollers are placed in a rack parallel to the floor and allowed to dry before reuse. Particular care must be taken that the fabric surfaces are not allowed to come in contact with any object which could cause depressions or flat spots.

c. Recovering Fabric Covered Rollers. Any fabric-covered roller that has many high or low spots, which has no nap left on the fabric, or which is extremely dirty even after scrubbing, should be recovered. This operation is quite simple, the procedure being as follows:

(1) Remove the old covering by cutting along the seam with a razor blade. Take care not to cut into the cover beneath.

(2) Check the undercovers to be sure that they are fairly clean and have no high or low spots. Unsatisfactory undercovers must be replaced. The method used is identical to that outlined below.

(*a*) Guide the larger end of the new cover (the end toward which the arrow, if present, is pointing) over one end of the roller and work it down until it overlaps the opposite end of the undercover by approximately $\frac{1}{4}$ inch.

(*b*) Tie a double strand of waxed string

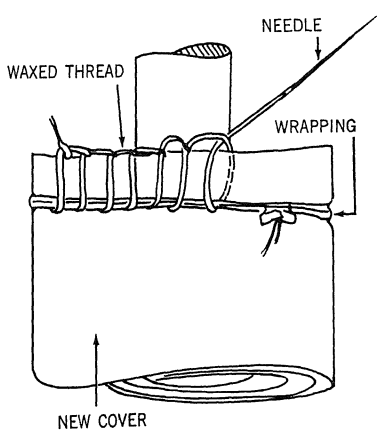


Figure 8–40. Recovering fabric rollers.

around the end of the roller, just over the undercover.

(*c*) With a needle and waxed string, take a saddle stitch around the end of the new cover with a half hitch through each loop, as shown in figure 8–40. Each stitch encloses the waxed string previously tied around the end of the roller, but it must not go through the fabric underneath.

(*d*) Pull the double string tight and tie its ends to the ends of the stitching string.

(*e*) Then draw the cover toward the end opposite to that which has been sewn until the cover is tight and smooth.

(*f*) Cut off the excess fabric with a razor blade ¼ inch beyond the end of the undercover.

(*g*) Again tie a double weight of waxed string around the end of the roller, just over the end of the undercover.

(*h*) Then sew the end in the same manner as the other end.

Section VII. INKING ASSEMBLY

8–22. Introduction

The inking assembly, consisting of an ink fountain, a ductor roller, vibrator rollers, intermediate rollers, and form rollers, transfers the ink uniformly to the plate as the plate cylinder revolves. This action follows the dampening of the plate. The ink clings to the image portion of the plate and is repelled by the dampened nonprinting areas. Figure 8–41 illustrates schematically the inking assembly of the ATF Model DP press.

8–23. Additional Nomenclature

Part	Function
Ink fountain	Used to hold the ink which is to be distributed through the inking assembly rollers to the plate. The feeding of the ink to the rollers is controlled by the fountain roller, the fountain blade, and the fountain keys (fig. 8–41).
Fountain roller	As it revolves, the fountain roller picks up the ink and transfers it to the ductor roller (fig. 8–41).
Fountain roller manual handle.	Used to turn the roller by hand when adding ink, setting the fountain keys, or washing up (not illustrated).
Fountain blade	Positioned in front of the fountain roller so as to form a trough for the ink supply. The size of the gap between it and the roller controls the amount of ink fed to the inking assembly rollers (fig. 8–41).
Fountain keys	Used to regulate the gap between the fountain blade and roller. Tightening the keys (turning them clockwise) closes the gap and decreases the flow of ink. They are not used to control the overall flow of ink. Each key regulates approximately 1 inch of the gap which makes it easy to adjust for the requirements of different portions of the image on the plate (fig. 8–41).
Automatic ink control unit.	Regulates the part of a revolution the ink fountain roller turns during each operational cycle of the press. The farther the fountain roller turns, the more ink is delivered to the rollers in the inking assembly. The operation of this unit is controlled by the ink control handle and the ink control lever (fig. 8–42 and 8–43).
Ink control handle	Regulates, by the height of its setting, the number of teeth the pawl on the automatic ink-control unit engages on the ratchet at the end of the fountain roller. The more teeth the pawl engages, the greater the distance the fountain roller revolves during one cycle of the press (fig. 8–42 and 8–43).
Ink control lever	When in its "down" position, this lever permits the ink-control pawl to engage the ink-control ratchet. When the press goes "on impression," the ink-control lever engages automatically. If it is desired to operate the ink-control unit with the press "off impression," the ink-control is manually pulled forward and downward (fig. 8–43).
Ink motion throw-off handle.	Used to control the position of the inking assembly form rollers in relation to the plate. This handle has three positions—"down" or "printing," "up," and "lockup" (fig. 8–28).

Part	Function
Ductor roller	Conveys the ink from the fountain roller to the rest of the inking assembly rollers by being in contact with the fountain roller part of the time and then arcing over to touch the adjoining vibrator or intermediate roller the remainder of the time (fig. 8–41).
Intermediate rollers	Transfer ink from one roller to another. They have their own bearings, do not oscillate, and are surface, or friction, driven (fig. 8–41).
Rider rollers	Nonadjustable, nonoscillating rollers sitting above some intermediate rollers (fig. 8–41).
Vibrator rollers	Do most of the work of smoothing out and distributing the ink evenly to the form rollers. The vibrator rollers move from side to side along their axes as they rotate (fig. 8–41).
Form rollers	Distributes the ink to the plate (fig. 8–41).

8–24. Operational Instructions

a. Adjusting Ink Fountain.

(1) *Turning fountain roller by means of manual handle.* At the end of the fountain roller spindle on the gear side is a large handle connected to the roller by a pawl and ratchet. By moving this handle forward and backward, the fountain roller can be rotated manually. It is used when adding ink, setting the fountain keys, or washing up.

(2) *Removing and replacing fountain blade.* The fountain blade is locked into place in front of the fountain roller by three bolts. Loosen these three bolts and remove the blade to wash up. The abutment plate rod assembly, under the fountain blade, is also removed for cleaning. This blade is made of flexible spring steel. Avoid binding, buckling, or otherwise damaging it. After the blade and fountain roller have been cleaned, and the abutment plate rod assembly returned, return the blade to its place and tighten the lock bolts.

(3) *Adjusting ink fountain gap by means of fountain keys.* Tightening the keys (turning them clockwise) closes the gap between the blade and the fountain roller and decreases the flow of ink. Loosening the keys (turning them counterclockwise) increases the flow of ink.

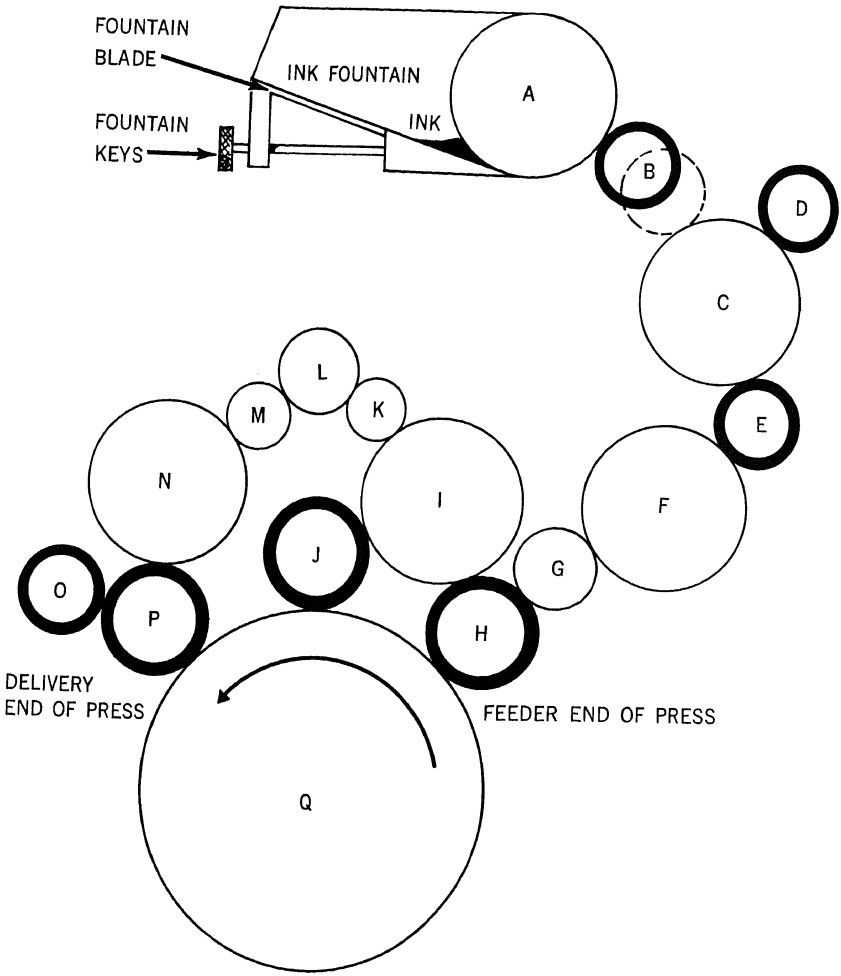
b. Setting and Adjusting Automatic Ink Control Unit. The ink-control unit regulates the part of a revolution the ink fountain roller turns during each operational cycle of the press. The farther the fountain roller turns, the more ink is delivered to the rollers in the inking assembly. To operate the unit on the ATF Model DP press, raise the ink-control handle (fig. 8–42) to the approximate center of its adjustment range. See that the ink-control lever (fig. 8–43) is in its "down" position. Start the press. After examining the amount of ink on the sheets being printed, move the ink-control handle up or down to increase or decrease the overall amount of ink being fed to the inking assembly rollers.

c. Positioning Form Rollers On or Off Plate by Means of Different Setting for Ink Motion Throwoff Handle. In paragraph 8–16*d*, which covers the operational instructions for mounting a plate on the plate cylinder, reference is made to the ink motion throwoff handle. Figure 8–28 illustrates the three settings for this handle—"down" or "printing," "up," and "lockup." In its "up" position, the form rollers clear the plate by approximately 1/8 inch. In the "down" or "printing" setting, the form rollers are against the plate and will ink the image on the plate as the plate cylinder revolves. The ink motion throwoff handle is connected to the impression linkage arm and drops or raises automatically when the press impression goes "on" or "off". The handle, however, can be locked in its "up" position so the form rollers will not drop to the plate automatically with the impression mechanism. When the press is not on impression, the handle can be raised or lowered manually.

d. Adjusting Ink Rollers—ATF Model DP.

(1) *Setting form roller 2 to vibrator roller.* Remove the rider roller, the three intermediate rollers, the two removable vibrator rollers, and form rollers 1 and 3. Replace the vibrator roller over form roller 2 and lock it down. Adjust the form roller to the virator roller by turning the lower allen setscrew. This screw is similar to and located just below the lower adjusting screw for form roller 3, illustrated in figure 8–44. Turning the screw in a clockwise direction moves the form roller toward the vibrator. This adjustment has no locking device. Check this adjustment with the ink motion throwoff handle in both the "up" and "down" positions.

(2) *Setting form roller 2 to plate.* This adjustment is made with the upper allen setscrew which has a locking nut that fits over the screw. The locking nut must be loosened before any ad-



A — Fountain roller
B — Ductor roller
C — Top vibrator roller
D — Top intermediate roller
E — Intermediate roller 2
F — Vibrator roller (nonremvosable)
The rollers drawn with a heavy outline are adjustable.

G — Intermediate roller
H — Form roller 1
I — Removable vibrator roller
J — Form roller 2
K — Intermediate roller
L — Rider roller

M — Intermediate roller
N — Removable vibrator roller
O — Auxiliary vibrator roller
P — Form roller 3
Q — Plate cylinder

Figure 8-41. The inking assembly—ATF Model DP.

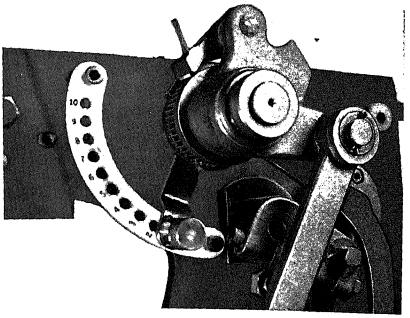


Figure 8–42. Automatic ink control unit—ATF Model DP.

justment can be made. Turning the allen setscrew in a *clockwise* direction moves the form roller *away from* the plate cylinder. After setting the form roller to the plate cylinder, reset it to the vibrator roller.

(3) *Setting form roller 1 to vibrator roller.* Take out the vibrator roller, remove form roller 2, replace form roller 1, replace the vibrator roller, and lock it down. The adjustment steps are similar to those outlined in the preceding paragraphs for form roller 2. The lower allen setscrew adjusts the form roller to the vibrator. Turning the screw in a clockwise direction moves the form roller toward the vibrator roller. This adjustment has no locking device. Check this adjustment with the ink motion throwoff handle in both the "up" and "down" positions.

(4) *Setting form roller 1 to plate cylinder.* The adjustments are the same as those outlined above for form roller 2. After setting the form roller to the plate cylinder, reset it to the vibrator roller.

(5) *Setting form roller 3 to vibrator roller.* Replace form roller 3 and the vibrator roller. The adjustments are the same as for the other two form rollers (fig. 8–44). Turning the lower adjusting screw in a *clockwise* direction moves the form roller *toward* the vibrator. Turning the screw counterclockwise moves the form roller away from the vibrator. Check this adjustment with the ink motion throwoff handle in both the "up" and "down" positions.

(6) *Setting form roller 3 to plate cylinder.* The adjustments are the same as those outlined above for form roller 2. Turning the upper allen setscrew in a *clockwise* direction moves the form roller *away from* the plate cylinder. After setting the form roller to the plate cylinder, reset it to the vibrator roller.

(7) *Setting auxiliary vibrator roller.* Set the auxiliary vibrator roller to form roller 3 with the thumbscrew on the end of the roller (fig. 8–45).

(8) *Setting the intermediate rollers.* Set the top intermediate roller to the top vibrator roller with the thumb screw on each end of the roller on the feeder side of the roller assembly (fig. 8–46). Set intermediate roller 2 by varying the spring tension which pulls it into contact with the two stationary vibrator rollers. (Make this adjustment only under the supervision of an experienced press operator because the cast brackets are fragile.)

(9) *Setting ductor roller.* The ductor roller on the ATF Model DP is self-paralleling. Adjust for overall pressure against the fountain roller with an eccentric stud located on the operator's side of the fountain.

e. Care and Cleaning of Ink Rollers.

(1) If rollers are in constant use, remove them and give them a thorough cleaning by hand every two weeks. During a run, ink and gum are gradually deposited on rollers and form a glaze which causes uneven and dirty printing, ghosting and streaks.

(2) When taking the rollers out for cleaning, arrange them so they may be reinstalled in their original order. This reduces the degree of roller adjustment.

(3) Wash with good ink solvent that will not swell rubber. When the ink is removed, mix some pumice in solvent to remove glaze. Clean the ends of the rollers and clean and lubricate the sockets and bearings.

(4) Clean metal rollers the same as rubber except that copper plated rollers are not pumiced.

(5) Store rollers in a cool, dry place *out of the sun.* Prevent roller surfaces from touching anything and so avoid low or flat spots on the rollers. Put operation buttons on *"safe"* when cleaning rollers manually.

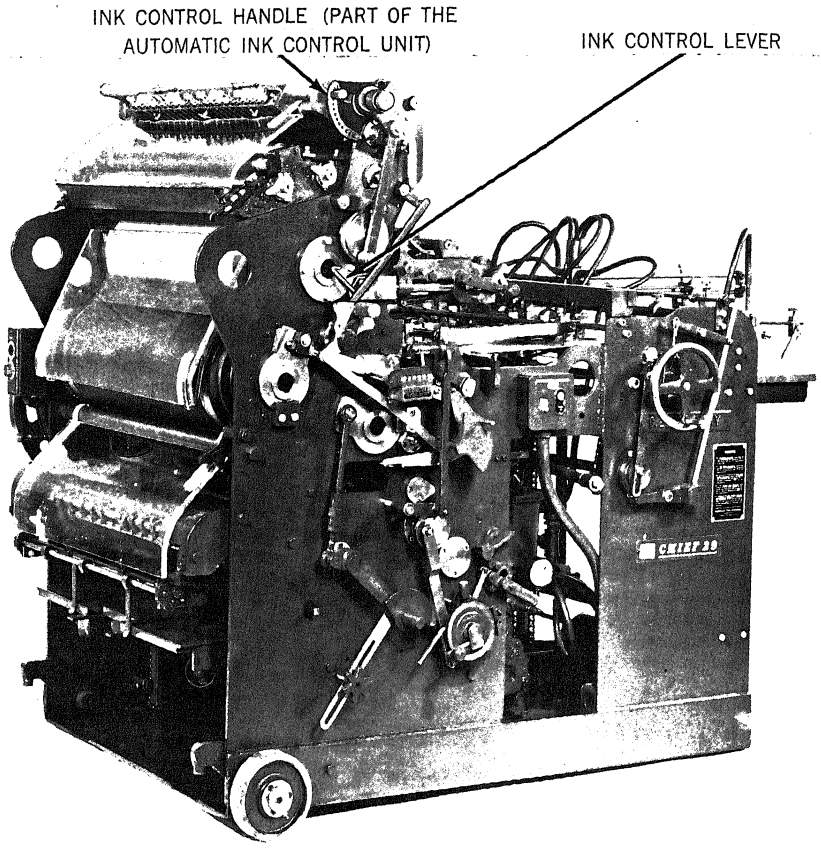


Figure 8-43. Ink control lever and handle—ATF Model DP.

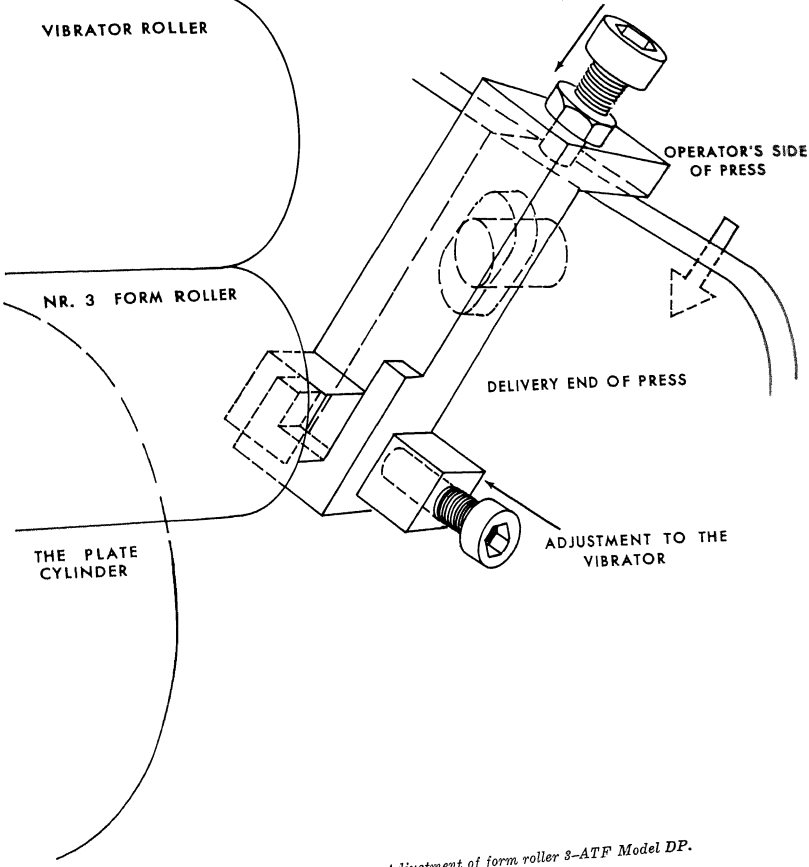


Figure 8–44. Adjustment of form roller 3–ATF Model DP.

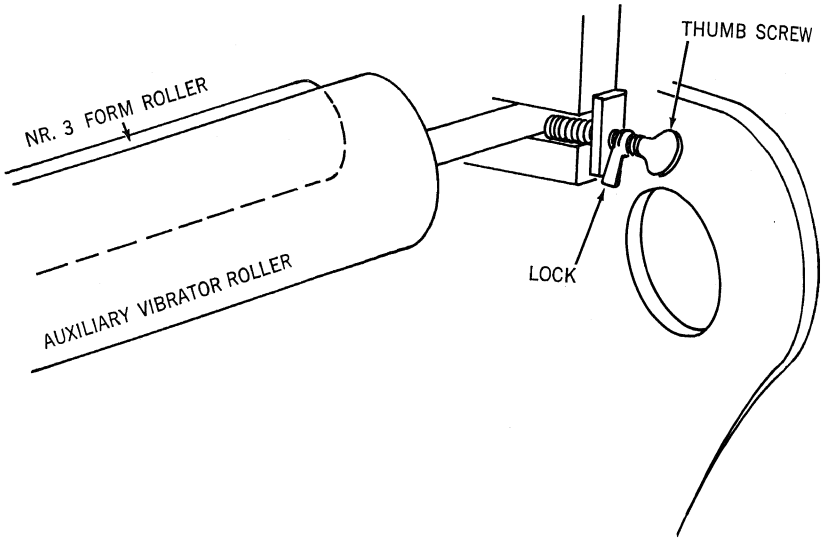


Figure 8–45. Setting auxiliary vibrator roller—ATF Model DP.

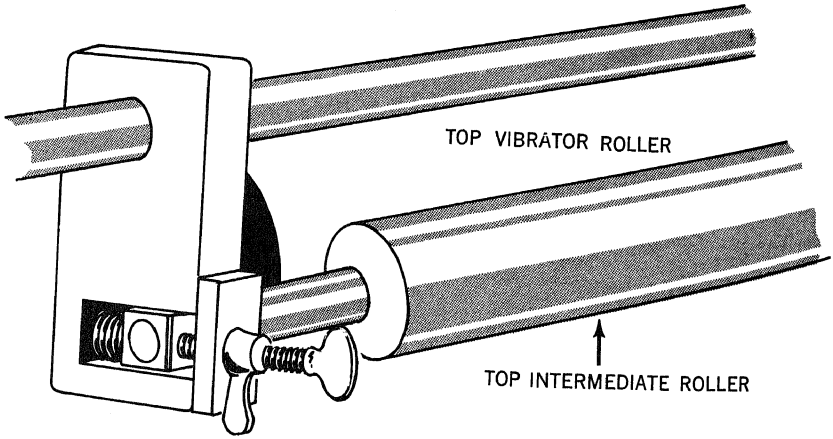


Figure 8–46. Setting top intermediate roller—ATF Model DP.

Section VIII. INK PREPARATION

8–25. Introduction

The ink used in offset printing is a greasy, semi-solid which adheres to the image portion of the plate and is repelled by the dampened, nonprinting portions of the plate. Its basic ingredients are the pigment, a liquid varnish called the "vehicle", and a drier. The pigment provides both the color and the covering quality of the ink. Since an extremely thin film of ink actually reaches the printed sheet, the ink must have a high color density. There must be enough pigment in the ink to completely "cover"; that is, to produce a dense, constant color even in this thin film. The vehicle carries the pigment, and when it dries, binds it to the printed surface. It imparts the greasy quality necessary for inks used in the lithographic process. The drier acts as a regulator to control the drying speed of the vehicle. The ink should dry rapidly enough to avoid smearing the next time the sheets are handled, but it should not dry so rapidly that it dries and cakes on the ink rollers.

8–26. Operational Instructions

a. Preparing Ink for Use.

(1) Remove the top from the ink can and, if the can has been opened before, scrape the dried ink skin from the surface of the ink. This is very important. It is better to throw away a little good ink than to allow any bits of dried ink to get on the press and form scales on the plate or paper. When removing ink from the can, leave the surface of the remaining ink smooth and even, and cover it with oiled or waxed paper. This will retard the formation of new surface skin.

(2) Place the ink to be mixed on a glass or metal slab and, using an ink knife or spatula, work the ink around with a rolling motion until it is possible to judge its consistency. An experienced pressman can tell from the "look" and "feel" of the ink how it is likely to behave on the press. An approximate idea of the consistency of the ink can be obtained by lifting the spatula from the slab and watching to see how high it can be raised above the slab before the strings of sticky ink break. If they break immediately, the ink is too thin. If the spatula can be raised approximately 8 inches before the strings of sticky ink break, then the ink may have the proper consistency. If no strings form at all and all the ink remains on the spatula, it is too thick.

(3) The preparation of the ink might be as simple a job as opening a new can of ink, dipping some out onto the mixing slab, working it with a spatula, and transferring it from the slab into the ink fountain. However, this represents an ideal situation and many complicating factors may enter into the procedure. The ink may be too stiff and dry even in a freshly opened can. It may be too thin and fluid. The paper stock may have a glossy surface which will prevent the ink from being absorbed into the paper. This will slow the drying time. After the sheets are printed on one side, they may have to be printed on the other side shortly thereafter and the ink may be too slow drying. Other complicating factors are the number of colors to be run, the type of image—whether halftone or line, and the temperature and humidity.

b. Modifying or Altering Ink With Additives. Most offset inks acquired through supply channels are ready for use under average conditions and need not be doctored with other ingredients. However, although it is desirable to use offset inks as concentrated and unreduced as possible, it is sometimes necessary to modify them to achieve certain results. Listed below are several types of additives or "doctors" used to modify the ink.

(1) *Varnishes.* Varnishes are of the best grade of boiled linseed oil, which give optimum drying qualities. The varnishes may be obtained in various viscosities or thicknesses, available in #00000, #0000, #000, #00, #0, #1, #2, #3, #4, #5, #6, #7, and #8. The zero-numbered varnishes thin the ink, while numbers 1 through 8 thicken the ink and add to its cohesiveness. The standard army issues are #00 and #8 varnishes. These two varnishes are sufficient to alter the ink to almost any desired consistency. However, the use of too much varnish is apt to make the ink too greasy, causing poor printing results.

(2) *Cobalt or liquid dryer.* Dryer is an agent that hastens the drying of printed ink on paper. Cobalt dryer is fast acting and should be used sparingly, never more than an ounce to a pound of ink. Any more than this does not increase the speed of drying on the paper to any appreciable extent, but greatly increases the speed of drying on the ink rollers. Cobalt dryer hastens the reaction of the ink with air, and may be said to dry "from the top down."

(3) *Paste dryer.* Paste dryer acts more slowly than cobalt dryer. However, no more than 1½ ounces should be used to a pound of ink. Paste

dryer hastens the setting or absorption of the ink into the paper. It may be said to dry "from the paper up."

(4) *Magnesia powder (magnesium carbonate).* Magnesia powder is sometimes mixed into thin or soupy inks to stiffen them and to cut down their greasiness.

(5) *Other "doctors."* There are a great many other materials that can be added to inks to alter their performance. Only experience can develop this skill. In general, all "doctors" reduce the strength and depth of an ink's color, affect the tack and viscosity, and either hasten or retard drying. Some inks require careful handling in order to print properly, and, therefore, the use of "doctors" should be avoided whenever possible.

c. Mixing Color Pigments. In topographic reproduction units, standard printing colors, identified by TOPOCOM nomenclature, are specified for mapping projects, and are furnished through normal supply channels. In other military printing units, however, the pressman may be expected to mix many needed colors from a few basic pigments. A knowledge of primary colors and the results of their combinations is thus necessary for color printing.

(1) *Pigment colors.* Briefly, red, yellow, and blue are the three primary pigment colors, as distinguished from the additive primary colors of the light spectrum discussed in paragraph 5–13 above. Any other color can, theoretically, be obtained by mixing these three primary colors in the proper proportions. A color wheel or chart showing the colors and their various combinations is very helpful in this connection (fig. 8–47). Colors that are opposite each other on the color wheel are called *complementary* colors. Mixing any two primary colors creates a color that is complementary to the third primary color. When printed together, such complementary colors usually create harmonious combinations, but if mixed together as pigments, they usually form a shade of gray. A study of the color wheel provides the explanation: mixing any color with its complement is equivalent to mixing the three primary colors together. If the strengths of the three colors are equal, the result is always a neutral gray pigment.

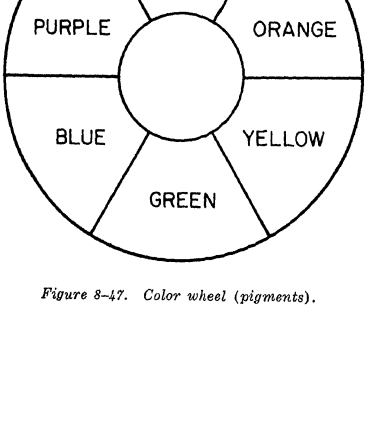


Figure 8–47. Color wheel (pigments).

(2) *Amounts of color.* When mixing a color from two or more colors, it is best to start with the lightest color and add the darker ones to it, a little at a time, until the desired result is obtained. This is not only the easiest method, but also the most practical. Other methods usually result in mixing more ink than is necessary.

(3) *Materials for mixing tints.* There are three materials which can be used for reducing color strength or tint making.

(*a*) *Opaque white.* Opaque white gives a color a milky appearance and helps to cover colored stocks or previously printed colors. No more than 10 percent should be used in any mixture, as it gives poor results on a lithographic press.

(*b*) *Reducing white.* Reducing or transparent white (also known as alumina hydrate) is best for mixing tints that are to be run with small or fine images on offset or hard surfaced papers.

(*c*) *Laketine.* Laketine is best for mixing tints that are to be run with solids on coated stock. Reducing white and laketine may be mixed to achieve desired results when using certain images and stocks.

d. Handling Ink. When the ink is properly prepared, pick it up from the mixing slab with a spatula and carry it to the ink fountain of the press. Turning the spatula continuously prevents the ink from falling off.

Section IX. MAKEREADY

8–27. Introduction

When preparing to print a job, the pressman first reads his work order, and then procures the proper plates, paper stock, and ink, and has all other necessary materials on hand. Then he sets up the feeder and delivery assemblies, packs the cylinders, and prepares the inking and dampening assemblies. Next, the plate is inked up, waste sheets are printed, position and color are checked and corrected, and an OK obtained from the supervisor or senior pressman. All of the preceding steps comprise what is known as the makeready procedure.

8–28. Operational Instructions

a. Collecting Required Materials. In addition to the tools provided with the press, the pressman must have many other materials on hand. Among these are: a bowl or pail, an ink solvent for use on rubber rollers and blankets, turpentine or a similar solvent to be used on the plate, gum arabic, plate etch, asphaltum, pumice powder, a half-and-half mixture of talcum powder and flowers of sulfur, a soft eraser, several etching needles, a quantity of rags, and a sponge. Check manufacturer's instructions, as turpentine and asphaltum are harmful to some plates.

(1) *Ink solvent for rubber.* The ink solvent for the rubber rollers and blankets should be one that has little or no detrimental effect on rubber. This is usually naphtha, or any one of a number of commercial preparations made especially for this purpose. Under no circumstances should gasoline, carbon tetrachloride, turpentine, kerosene, or any mineral oils be used.

(2) *Ink solvent for plate.* The ink solvent for use on the plate is usually turpentine. Other commercial preparations may be used for the same purpose.

(3) *Gum arabic (acacia).* Gum arabic is pitch taken from the acacia tree. It is soluble only in water. It is used as a protective coating on the nonprinting areas of the plate. It is also used in the fountain solution. Gum arabic is applied to the plate whenever the press is stopped for a period of time. It is applied with a sponge, smoothed with a damp rag, and removed from the plate with a sponge saturated with water.

(4) *Plate etch.* Plate etch is a solution, containing one or more acids, used to make the nonprinting areas receptive to water. It can cause skin irritation if proper precautions are not taken. Plate etch is applied to a plate and removed with a sponge.

(5) *Asphaltum.* Asphaltum is a thick, greasy liquid. Because it never dries to a really solid form, it is used to protect the image areas of a plate that is to be stored for a considerable length of time. It is also used to restore ink receptiveness to an image that has become weak. It is soluble in turpentine.

(6) *Pumice powder.* Pumice powder is a fine abrasive. It may be used to scour the blanket, to grind a new grain into small areas of the plate, or as a scouring powder on almost any surface. Pumice powder is applied to a plate with a rag dampened with either water or plate etch. It is removed with a rag saturated in water. The plate must be etched with plate etch after using pumice.

(7) *Talcum-sulfur powder (blanket dust).* The talcum powder and flowers of sulfur mixture is used to preserve and revive the tackiness of rubber blankets.

(8) *Soft eraser.* A soft eraser is used to remove unwanted work from presensitized and wipe-on plates.

(9) *Etching needles.* Etching needles are used to add or delete fine work from the plate.

b. Job Work Order. Each job should be accompanied by a work order giving pertinent information concerning the job, such as the color of ink, the type of stock to be used, the number of sheets required, the number of plates, and the completion date.

c. Setting Feeder and Delivery Assemblies. Adjust the feeder and delivery assemblies to the size and weight of stock to be used (see para 8–8 to 8–13 for detailed instructions covering these adjustments).

NOTE

Safe switches must always be in the "safe" position when setting the feeder and delivery assemblies.

d. Mounting Plate (and Blanket). Mount the plate and, if necessary, the blanket on their respective cylinders. Usually the blanket is already mounted, and the pressman need concern himself only with mounting the plate (see para 8–14 to 8–16 for detailed instructions covering the mounting of the plate and blanket).

NOTE

Safe switches must always be in the "safe" position when mounting either the plate or the blanket.

e. Preparing Inking Assembly. Check all adjustments of the ink rollers (see para 8-22 to 8-24 for detailed instructions covering the ink roller adjustment).

NOTE

Safe switches must always be in the "safe" position when adjusting the inking assembly rollers.

Mix the ink according to the work order specifications. Tighten all the ink fountain keys by turning them clockwise and then back them off ⅛ turn. Turn the press until the ink ductor roller contacts the fountain roller. Then place the ink in the fountain. Adjust the fountain keys while turning the fountain roller, with the ductor roller contacting it, and observe the distribution of ink on the ductor and fountain rollers. Adjust the fountain keys so that they will distribute the ink according to the requirements of the plate.

f. Preparing Dampening Assembly. Check all adjustments of the dampening assembly rollers (see para 8-17 to 8-21 for detailed instructions covering these adjustments).

NOTE

Safe switches must always be in the "safe" position when adjusting the dampening assembly.

Mix gum arabic, acid, and water to make a fountain solution of the proper pH and fill the fountain.

g. Inking Plate.

(1) Put the dampening assembly in position 2 (para 8-19*a*), lower the water-on lever, and engage the ink-control handle and lever. Before starting the press, check to see that it is clean. Then start the press and allow it to idle until the dampening rollers are wet, but not soaking, and the ink rollers are carrying a sufficient film of ink.

(2) Then sponge the plate with water to remove the protective gum arabic coating and start the press. Since the developing ink in the image areas of a new plate may have dried, it is best to start drop the ink rollers so that the image will be charged with fresh ink, then move the dampening assembly to position 1. This will prevent the acid in the fountain solution from attacking the image. After subsequent wetwashes, however, the dampening rollers must be contact the plate first to remove excess water. After several press revolutions, raise the ink rollers, put the dampening assembly in position 2, stop the press, and examine the plate for proper inking. Sponge the plate with water to prevent it from drying out and oxidizing. If the image on the plate does not take ink properly, it must be made to do so before proceeding. Among the many causes of this difficulty, called a "blind image", are—improperly set ink rollers, glazed ink rollers, improperly set ink fountain, or gum streaks or spots.

h. Printing First Sheets.

(1) In order to print sheets for checking position and color, start the press and put the dampening assembly in position 1. Check the plate for dampness and lower the ink rollers against the plate. This is a good habit to cultivate, as it not only decreases the possibility of accidentally "rolling up" the plate, but also increases the quality of the first few sheets.

(2) Print three to five sheets by starting the air pump, raising the feeder valve, pushing the impression-on lever down, as the first sheet reaches the front guides, and turning the air pump off immediately afterward.

(3) Then stop the press, put the dampeners in position 2, and sponge the plate with water.

i. Checking and Correcting Image Transfer.

(1) Examine the printed sheets to check the transfer of the image from the plate to the blanket to the paper. All of the image on the plate must reach the paper.

(2) If the image does not transfer properly, it must be made to do so before proceeding. Among the many causes for this difficulty are: an insufficient blanket packing and a dented or cut blanket.

(3) Lower the ink rollers to the gummed plate while the press is idling (off impression). Since the plate is dry, its entire surface will accept ink. Then put the press on impression for two or three revolutions (with the impression cylinder backed off), transferring the ink to the blanket. All smashed or dented areas will not accept ink and can now be marked for additional localized packing. After correcting this condition, clean the plate and blanket.

j. Checking and Correcting Position.

(1) Examine the printed sheets to check the

position of the printed image on the sheet. The image is positioned on the sheet in two directions —parallel to and a certain distance away from the gripper edge of the sheet, and centered side to side (inside the long dimension) on the sheet. There are several ways of checking the position of the image by tearing or folding the printed sheet. Corner marks on the plate are used to aid in positioning. The image can be straightened on the sheet by twisting the plate to a different position on the plate cylinder. The maximum amount that the plate can be twisted is approximately 1/8 inch. (Para 8–16*g* gives full instructions for twisting the plate.)

(2) The amount of gripper margin can be changed by swinging the plate cylinder to a different position in relation to the blanket cylinder. The maximum plate cylinder swing is 1½ inches (¾ in. either way from the center point). (Para 8–16*g* gives full instructions for swinging the plate.) The amount of gripper margin can also be changed by back-and-forth adjustment of the front guide bar to allow the sheet to be gripped in a different position on the impression cylinder. One full turn of the horizontal front guide bar screw equals approximately 3/64 inch change in gripper margin. The maximum change in gripper margin, by moving the front guide bar, is approximately 3/16 inch (3/32 in. either way from the center point). The registration wheels must be reset to the tail edge of the sheet after moving the front guide bar.

(3) The image can also be straightened on the sheet by turning the front guide bar out of parallel. This is not a recommended procedure, as misregister may result.

(4) The side-to-side position of the image can be changed by moving the side guide. For large changes (over $\frac{1}{16}$ in.), the side guide can be moved by loosening the vertical knurled locking screw above the side guide, moving the side guide to the desired new position, and retightening the locking screw. For small changes, the flange of the side guide can be moved by turning the horizontal micrometer screw alongside of the side guide. Moving the side guide closer to the center of the press causes the image to print closer to the side guide edge of the sheet. If the side guide has been moved any considerable distance, it is necessary to move the feeder pile until 1/8 inch side guide push is again obtained. The registration wheels should also be checked and reset, if necessary.

k. Running Waste Sheets.

(1) Print the same waste sheets and examine them for ink-water balance and "color." The amount and distribution of ink and water will be adjusted as needed and more waste sheets run until the proper density of color is obtained.

(2) In general, if the ink smears too easily on the printed sheet, there is too much ink being used. If the plate appears to be wet while sheets are printing, there is too much water being used. If the ink on the sheet has a gray, listless appearance, there is too much water being used. If a scum of ink appears in the nonprinting area of the plate, not enough water is being used.

(3) Run some sheets through the press twice and examine them for a blur. If a blur is present, it indicates misregister. The registration devices of the feeder must be adjusted where necessary to overcome this difficulty.

l. Getting Sheet OK'd by Supervisor. When a sheet with proper margins and color is printed, take it to the supervisor or senior pressman for an OK. Place the OK'd sheet in the work order jacket. All future copies must duplicate this sheet.

m. Starting Run.

(1) In order to check register during a run, use a pencil or a needle to make small registration marks on the plate in such locations that they will print at the extreme edges of the stock. Make these marks on the side guide side of the plate and on the side opposite. Position both marks near the gripper edge of the plate. The mark on the side guide side is a small "tee" with the head of the "tee' parallel with and as close as possible to the edge of the sheet. The mark on the opposite side is merely a short line perpendicular to the edge of the sheet and running off it. After some sheets have been run through the press, take 10 or 12 of them from the delivery board and, keeping the gripper edge of all the sheets alined, "fan" or "slide" them sideways slightly. The location of the registration mark on each sheet in comparison with the other sheets indicates at a glance whether the various registering devices are adjusted and working properly.

(2) Set the counter at zero, and adjust the automatic pile receder to the thickness of the stock being run. The actual run can then be started.

(3) During the run, check the sheets frequently for misregister, scumming, filling in, or variation in color or amount of ink. If any difficulty appears, turn off the air pump and determine and correct the cause of the difficulty before continuing. See appendix E for a list of common printing difficulties.

n. Ending Run. When the last sheets feed through the press, turn off the air pump and let the press idle for two or three revolutions with the ink and dampener rollers riding the plate surface. Then remove the ink and dampener rollers from the plate surface and stop the press. The extra charge of ink will protect the image when the plate is gummed and wiped dry.

Section X. WASHUP PROCEDURE

8–29. Introduction

A press with ink in it must not sit inactive for very long because the ink begins to dry on the rollers and in the fountain. If the press is to be inactive overnight or for several hours, or if a new color of ink is to be run, the press must be "washed up" thoroughly. In washing up, the blanket and cylinders, the dampening assembly, and the general press area are cleaned, as well as the inking assembly.

8–30. Operational Instructions

a. Materials Required. The materials required for washup are: an ink solvent for use on rubber, a can with a spout (like an oil can), a washup tray, some sheets of paper, a sponge and water, plate etch, pumice powder, an ink knife or spatula, and several absorbent rags.

b. Preparing for Washup.

(1) Remove all stock from the delivery board.

(2) Fold some waste sheets of paper over the dampening assembly to protect the molleton covering on the rollers.

(3) Scrape the unused ink out of the ink fountain, place it in an ink can if it is still usable, and mark the can with pertinent information as to any "doctors" which may have been added.

c. Cleaning Inking Assembly.

(1) Remove the ink ductor roller, tighten thumb screws, and hand clean with rags and solvent. This is the only ink roller which remains out of the press during washup.

(2) Remove the ink fountain blade and hand-clean with rags and solvent.

(3) Hand-clean the ink fountain roller with rags and solvent.

(4) Place the washup tray in position and secure against the front vibrator.

(5) Start the press. If the ink is hard to clean off, the addition of fresh ink or clear varnish may be necessary to assure a clean washup.

(6) Using a can with a spout, pour solvent over one-half of the ink rollers. If solvent is poured across the full length of the rollers, there will not be enough friction to turn the friction-driven rollers.

(7) Use only enough solvent to loosen the ink from the rollers. Any excess solvent will splatter over the press and cause much extra work.

(8) When half of each ink roller is clean and dry, pour solvent in the same manner on the other half of the ink rollers.

(9) When the ink rollers are clean and dry across their full length, stop the press.

(10) Remove the washup tray, dispose of its contents among the dirty rags, and hand-clean the trays with rags and solvent.

(11) Clean off the strip of ink left on the vibrator roller by the washup tray with a rag and solvent.

(12) Turn the press by hand with the flywheel and clean the ends of the rollers with a rag and solvent.

d. Cleaning Dampening Assembly.

(1) Remove the protective sheets of paper from the dampening assembly after the inking assembly has been cleaned.

(2) Sponge up the solution from the water fountain and throw it away.

(3) Scrub the dirty fabric covered dampener rollers, rinse them, and hang them in a rack to dry.

(4) Clean the metal dampener rollers with pumice powder and water, and gum them.

e. Cleaning Cylinder Assembly.

(1) Wash with solvent and regum the plate, if necessary.

(2) Remove the plate.

(3) Clean the surfaces of the plate and impression cylinders and the bearers of the plate and blanket cylinders of all ink, gum, and dirt.

(4) Wash the rubber blanket with water first and then scrub it with solvent and pumice powder. Powder it with a mixture of sulfur and talcum.

CHAPTER 9
BINDERY OPERATIONS

Section I. INTRODUCTION

9-1. Processing the Printed Product

a. The lithographic cycle is not necessarily complete with the printing of the sheets on the offset press. Additional processing is frequently necessary before a final product is delivered to the user. This processing may include trimming and cutting, folding, stitching or other binding, punching, padding, or perforating, depending on the nature of the finished product. Military printing plants generally are equipped to perform most of these functions.

b. Standard military maps normally do not require either cutting or folding. Their formats have been designed to fit the sheet size handled by field presses, and any necessary trimming of stock is done before the maps are printed. Among the few exceptions are special purpose maps, such as road maps and air charts, which usually are accordion-folded to facilitate handling by the vehicle operator, pilot, or navigator.

c. Other products of military printing plants usually require cutting, and sometimes drilling, punching, folding, collating, and binding. Chapter 6 of this manual discusses the arrangement of material on flats for combination layouts. Proper planning at the layout stage eliminates many subsequent problems in the bindery. Forms are almost always printed in multiples, and sometimes combine different sizes and shapes on one sheet, requiring careful cutting to separate them. Pamphlets must be correctly folded, and the pages of books and booklets, besides being folded, must be fastened together and trimmed.

9-2. Equipment

The extent of bindery operations varies greatly among military printing plants, ranging from simple cutting and trimming to the binding of good-sized books. The equipment available for these operations also varies widely. This chapter discusses the characteristics and operation of a typical, power-driven cutter, buckle-type folder, and wire stitcher. Although the make, model, and capacity of any such equipment in a particular installation may differ from those discussed herein, the principles of operation are the same. The operator should have both a complete understanding of these principles, and a thorough familiarity with the make and model he operates. The operation and maintenance manuals or the manufacturer's instructions for each model provide the necessary specific information.

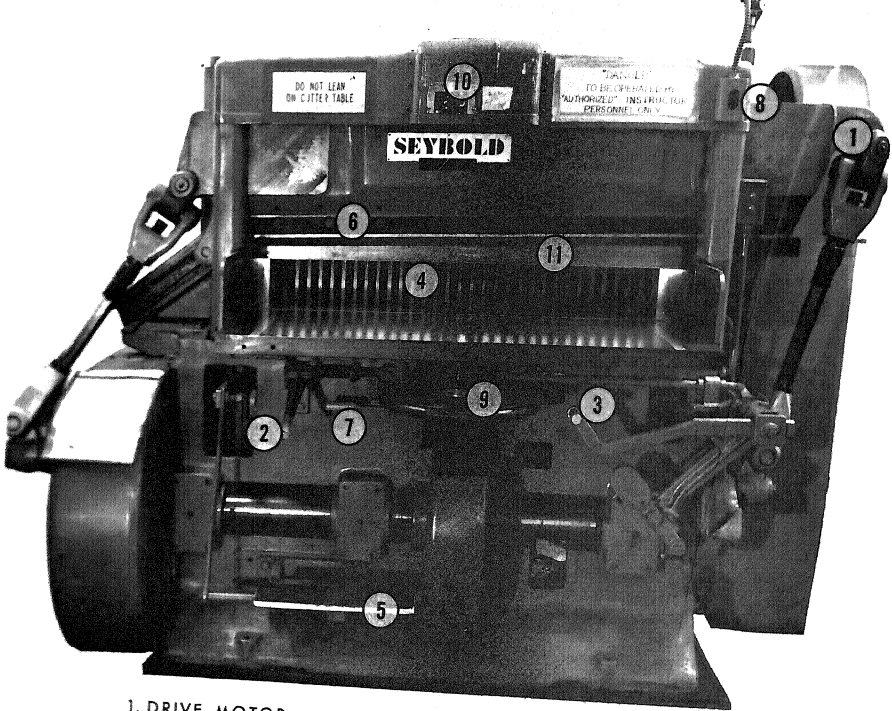
Section II. POWER-DRIVEN CUTTER

9-3. Description

The power-driven cutter (fig. 9-1), once it has been set and the paper loaded, operates automatically. The position of the back gage, which is a movable, fingered metal bar, determines the width of the cut. The paper is loaded on the cutter table and jogged against the back gage, which has been positioned the desired distance from the knife by means of a handwheel. The operator raises the safety lever with one hand and depresses the knife lever with the other. The knife cannot be depressed until the safety lever is raised. After the cut is made, the knife returns to its original position and is automatically locked to prevent a repeat stroke. The braking mechanism is similar to that on an automobile and requires the same kind of care and occasional adjustment. There is an automatic clamping device which descends just ahead of the knife to hold the paper flat. This clamp can also be operated with a foot treadle, independently of the knife.

9-4. Safety

Good safety practices, which are essential



1. DRIVE MOTOR
2. SAFETY LEVER
3. KNIFE LEVER
4. BACK GAGE
5. FOOT TREADLE
6. KNIFE
7. LOCK LEVER
8. CONTROLS
9. HAND WHEEL
10. DIAL
11. CLAMP

Figure 9–1. Power-driven cutter.

[illegible] the lithographic cycle, assume critical [illegible] the operation of the cutter. The [illegible] sever fingers and hands, and although [illegible] are built-in safety features, careless[illegible]ration or maintenance can cause bodily [illegible] damage the machine. A damaged or [illegible] cutter can be a serious safety hazard.

a. One Operator. At any given time, only one [illegible] shall operate the paper cutter. The design [illegible] safety lever insures that both hands of the [illegible] are out of the range of the blade when the cutter is in operation. If more than one person operates the levers, the safety aspect of this feature is eliminated. Men handling paper before or after cutting should keep clear of the machine and operating area.

b. Foreign Material. Check all stock for material that would cause damage to the blade, such as wood chips or steel rulers.

c. Dull Knife. Do not increase the pressure to eliminate cutting difficulties caused by a dull knife, as this could spring the knife and make it

hazardous to use. A piece of soap or wax rubbed along the bevel makes a dull knife cut easier, and gives a cleaner face to the cut. Apply lubrication very lightly, however, and do not lubricate when the knife is sharp. Changing knife blades should be done only by experienced operators. If the blade is over 40 inches long, two men are needed to change it.

d. Brakes. Do not oil or grease the brake leathers, as this makes the brake ineffective. If there is a downward creep of the blade at the end of each stroke, the brake may need adjustment. Consult the manufacturer's instructions for the particular model of cutter before attempting to adjust the brake.

e. Safety Washer. The safety washer is a gear-like connector on the end of the drive shaft which is designed to break under less stress than the rest of the machine. This prevents serious damage to the cutter. If a safety washer breaks, it must be replaced after the cause of the break is determined and corrected. Some causes are a dull knife, grabbing clutch, loose drive shaft brake, foreign matter in the gear train, excessive clamping pressure, and excessive cutting load. After the cause of the break has been corrected, remove the safety washer screw in the drive shaft end, engage the clutch and turn the flywheel by hand. When the tongue on the drive shaft is perfectly aligned with the tongues on the gear, install the washer, replace the screw, and tighten.

f. Housekeeping. Poor housekeeping in and around the cutter contributes to many accidents. Wet floors or improperly stored equipment can cause trips and falls. These are always dangerous, but near the cutter, they are doubly so. Keep the area clean, the floors dry and unwaxed, and all equipment in its proper place when not in use.

9–5. Care of the Cutter

a. Blade Adjustment. Cutting completely through the stock depends upon proper adjustment of the blade to the cutter stick. This setting is done by maintenance personnel either in the field or at base operations.

b. Keep the Knife Sharp and the Machine Oiled. Always keep the knife sharp and the machine well oiled to prevent friction and loss of power.

c. Cutting Sticks. Do not allow the knife to drive into the cutting stick. This usually is caused by improper blade adjustment. Turn or replace the cutting stick when clean cuts can no longer be made.

d. Hard Jogging Against Back Gage. Do not jog the paper *hard* against the back gage. Continued heavy jogging against the back gage will throw it out of alignment.

e. Oil Table and Knife. When the cutter is not in use, cover the knife and table with a thin coating of oil to prevent rust.

f. Lubrication Guide. Consult the lubrication guide in the manufacturer's instructions to make sure the recommended type of oil and grease is used during maintenance of the paper cutter.

9–6. Operating Controls

(Nos. in parentheses are keyed to fig. 9–1)

a. Starting Drive Motor. To start the main drive motor (1), push control button (8) and allow a few seconds for the motor to accelerate the flywheel to running speed before cutting.

b. Safety Handle. To actuate the cutting cycle the safety lever (2) must be lifted with the left hand before depressing the knife lever (3) with the right hand. This is the most important single safety feature of the cutter. The knife lever cannot be depressed until the safety lever has been lifted. The operator cannot have his hands under the cutter if both hands are on levers simultaneously.

c. Back Gage. To move the back gage (4) forward or backward, turn the hand wheel (9), located under the cutting table. This shows the length or width of the cut on the dial (10) located above the cutting table, when the paper is flush against the gage. To adjust the gage for a cut, turn the hand wheel until the desired measurement is correct on the dial. A lock (7) is provided for this wheel when repeated cuts at the same dimension are to be made.

d. Foot Treadle. A light foot pressure on the treadle (5) will lower the clamp (11) when the knife is not operating. This holds the top sheets of paper in register until the clamp pressure is applied by the machine. It also aids in pressing the air from the paper.

9–7. Operations

a. Handling Paper.

(1) *Size of lifts.* When transferring stock from skid to cutter table, it is important to avoid disturbing the alinement of the paper in the stack.

It is better to take small amounts, rather than large quantities that can easily shift out of alinement.

(2) *Paper curling.* If the paper curls up at the back against the gage, it will not cut accurately. Turn it over so the top sheets are flat, or put a weight on top if the cut is of sufficient width that the weight will not interfere with the clamp. Paper usually cuts better when the curl is down.

(3) *Jogging paper.* Jog paper against the gage by pressing the ball of the thumb against the front of the lift from top to bottom. Jog paper against the gage and side frame before each cut. Tamping with a wood block helps to keep paper in line. Do not move the gage until the entire amount of stock has been cut.

(4) *Cutting large sheets of paper.* When cutting large sheets of paper, drive the air from between the sheets before the full clamp pressure is applied; otherwise the paper may slip out of register. This is easily done by drawing a weight across the paper. Then a gentle pressure of the clamp with the foot treadle will drive out additional air before the full clamp pressure is applied.

b. Size of Lift.

(1) *Space.* Leave about 1½ inches between the top of the lift and the bottom of the clamp when cutting 22 x 29 map stock so that the knife may gain full momentum before striking the paper.

(2) *Stock peculiarities.* Some stocks are harder to cut and harder on the knife than others, and put a greater strain on the machine. Newsprint, book paper, and onionskin are examples of easy to cut paper. Coated, cover, and gummed papers are stocks that are hard to cut.

(3) *Lift heights.* The desirable height of lifts varies, but in most cases the lift is limited to three or four inches in order to eliminate *draw*. *Draw* is the slight difference in size between the top sheets of a lift, and those on the bottom. When cutting sheets in very close register reduce the lift to not more than 3½ inches.

(4) *Reduce draw with cardboard.* To reduce the draw in tough stocks, put two or three sheets of cardboard on top.

c. Cutting Printed Stock. Work that has been printed on the press may not always be square and true; therefore, it cannot be jogged against a straight edge gage and cut accurately. When cutting printed material, be sure to determine if there is a bad edge; if there is, do not jog that edge. Printed material must be jogged in perfect register. Be sure all printing guide marks and edges are in the same position throughout the lift. Bookwork normally is trimmed according to tick marks. Maps usually are not trimmed.

Section III. PAPER FOLDING MACHINE

9–8. Description

(Nos in parentheses are keyed to fig. 9–2)

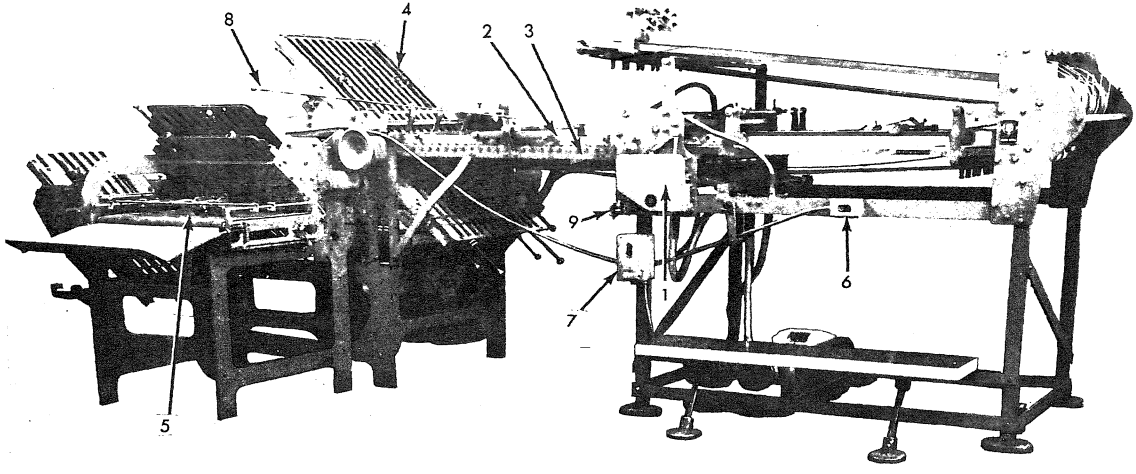
Most military printing plants are equipped with knife-type folding machines. These folders usually produce both parallel and right-angle folds, the number depending on the size and capacity of the machine. All folding machines consist of a feeding mechanism (1), a register (2), and conveyor (3), one or more folding units (4), and a delivery unit (5).

The folding unit operates in the following manner:

1. The sheet of paper is fed between two rollers which carry it to a fold plate, consisting of two metal plates with a stop, or gage, between them, set at the desired distance.
2. When the edge of the sheet reaches the stop, the paper buckles, and a third or fold roller forces the buckled part of the sheet and moves it forward, at the same time placing a fold at the point of buckle. Additional folding units repeat this procedure until the required number of folds have been made.

(3) If it is desired to by-pass a particular folding unit, a deflector is placed at the entrance to the fold plate, where it will cause the sheet to move on to the next part of the cycle.

c. The folder described in this section (fig. 9–2) is typical of those used by military printing plants. It can fold up to a 32-page signature, and can handle stock ranging in size from 5 x 7 inches to 25 x 38 inches, and in weight from 9-pound onionskin to 140-pound index. It can produce both parallel and right-angle folds in a number of combinations (para 6–14). An optional pasting attachment can be used to paste 6- and 8-page leaflets together, thus avoiding additional processing in the bindery.



1. Feeding Mechanism
2. Registering Unit
3. Conveyor
4. Folding Unit
5. Delivery Unit
6. Control-Folder
7. Control-Blower-Vacuum
8. Feeder Control Rod
9. Variable Speed Control

Figure 9–2. Paper-folding machine.

d. Cross Carrier. The cross carrier is mounted at the end of the parallel section of fold if cross folds are required. It is similar to the feeder board, having a series of diagonal rollers with a side guide to insure the straight line feeding of paper into the next set of folds.

9–13. The Power Train

Gears control the power transfer from one section of folds to another. To hook into another section of folds—other than the parallel section which is on a direct drive—use a screwdriver to engage the gear on the shaft while the folder is not running. The gears are on the operator's side of the folder between the parallel section of folds and the 8-page section of folds, and also between the 8 and 16, and the 16 and 32-page sections.

9–14. Lubrication and Maintenance

Regular lubrication, in accordance with the manufacturer's instructions, is essential for long service and proper operation of the folding machine. There are many grease fittings, oil cups, ball oilers and oil holes on each model of this type of equipment. Be sure to use the recommended weights of oil and grease.

Section IV. PAPER STITCHING MACHINE

9–15. Description

(Nos. in parentheses are keyed to fig. 9–9)

a. The paper stitching machine described in this section is a typical wire stitcher commonly used in military printing plants. It is more versatile than the stapler-type fasteners because, using a spool of wire instead of preformed staples, it can be adjusted to a greater range of paper thicknesses.

b. The wire stitcher consists of three main components: the head, which contains the spool of wire (1) and the feeding (2), straightening (3), and cutting (4) devices; the work table (5), on which the work is placed; and the foot treadle (6), which operates the machine (fig. 9–9).

c. Types of Wire. This machine can operate with either flat wire, in size 21 x 25, or round wire, in sizes No. 30, 28, 26, and 25. The larger the number, the finer the wire. Since flat wire has a tendency to take the curl of the spool, it should always be passed through the wire straightener first.

d. Methods of Stitching. This model of stitcher uses both the saddle stitch, used to bind folded books and booklets, and the flat stitch, used to bind signatures or individually printed sheets stacked together (fig. 9–10). The saddle stitch is made along the fold of the opened work; the flat stitch is made along the folded edges of the stacked signatures, or the left margin or top of cut sheets.

9–16. Operation

Before operating the stitcher, it must first be threaded, and set for the proper stitching thickness. The table must be adjusted for either saddle or flat stitching.

a. Threading the Machine. To thread the machine, place the spool of wire in the bracket so the wire feeds down from the top of the spool. Pass the wire from the spool through the eye in the top of the straightener. The straightener is a spring steel arm that holds the wire taut and also removes any kinks or curls in it. From the eye, pull the wire down to the straightener pin. Pass the wire under the first pin, over the second pin, and under the third pin. Pass the wire between the feed pin and the feed sector. To prevent misfeeding, keep the wire taut at all times while loading. Pass the wire under the wire check, through the cutting tube and supporters. After the machine is loaded, make a few stitches to check the feed sector for proper operation.

b. Adjusting the Table.

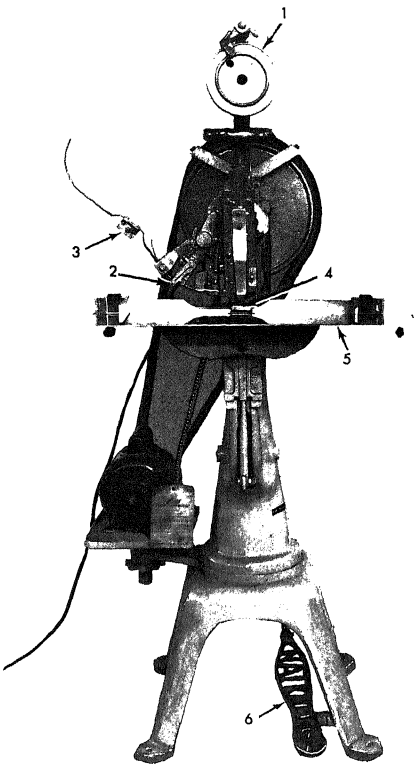
(1) To set the table for saddle stitching, disengage the work table arms so the table breaks down the center and forms a saddle—an inverted V.

(2) For flat stitching, raise the work table and engage the table supports. The two halves form a flat work table to support the material to be stitched.

c. Setting for Stitching Thickness.

(1) Open the head by turning the handwheel; this both opens the gap and automatically sets the feed of the wire to the desired length.

(2) *Gage Clamps.* Place the paper to be stitched into the gage clamps. If a saddle stitch is to be made, measure only the thickness of the part



1. Spool of Wire
2. Feeder Pin
3. Straightening Pin
4. Cutter
5. Work Table
6. Foot Treadle

Figure 9-9. Wire-stitching machine.

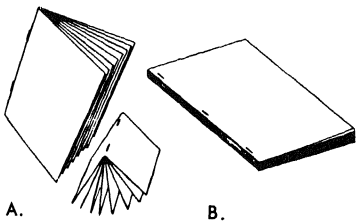


Figure 9-10. Two methods of stitching: a. saddle; b. flat.

to be stitched. Turn the hand wheel until the gage clamps hold the paper firmly, but still allow the paper to be withdrawn.

(3) *Maximum thickness.* This stitcher binds paper up to a maximum of 3/8 inch thick. Use a size of wire strong enough to keep from bending before it passes through the paper.

d. Stitching the Copy.

(1) In saddle stitching, the copy is opened and positioned so that the fold is centered on the apex of the V-shaped table. Holding the paper in place, depress the foot treadle to stitch the copy.

(2) In flat stitching, a guide bar with movable stops is adjusted as required to aid in the correct placement of the copy and the spacing of the stitches. As with saddle stitching, the machine is activated by depressing the foot treadle.

(3) During operation, check the stitching at regular intervals. If the machine is correctly adjusted, the staples will fold neatly and evenly against the underside of the work.

9-17. Care of the Stitcher

a. Turning the Cutter. If one or both ends of the wire do not drive through the folded work, buckling the staple, the problem can frequently be traced to a dull circular cutter, which does not cut the wire clean and square. To get a new and sharp cutting edge, turn the cutter to a new position. Be sure to see that the screw holding the cutter is securely tightened after the cutter is turned.

b. Lubrication. Lubricate well with a good grade of machine oil. Occasionally apply a little oil on the sides and front of the former and driver bars. Apply very little oil to these bars as excess oil will drip down onto the work.

9-18. Safety

As with most of the power-driven equipment in the pressroom and bindery, carelessness in the operation of the wire stitcher can cause injury. The following safety practices must be observed at all times.

a. Position of Hands. Keep hands well away from the stitching area when guiding the work. Since the staple former and head hold the paper securely in place, there is no need to have hands too close to the stitching area.

b. Position of Foot. Depress the foot pedal only when you are ready to stitch. The stitching move-

operation of this machine continues as long as the foot pedal is depressed, even if the wire is depleted.

Disconnect Power When Adjusting. Disconnect the power cable from the power source when any adjustments are to be made on the stitcher. This prevents the machine from accidentally starting a stitching cycle.

CHAPTER 10
MAP REPRODUCTION TRAIN

10–1. Introduction

a. The mobile map reproduction train consists of a group of truck-mounted vans containing the equipment for producing maps and related printed material in the field by photolithographic methods.

b. The basic reproduction van body has fixed, insulated walls, floor, and roof. It is 208½ inches long, 96 inches wide, and 94 inches high and is mounted on a 4 DT 190-inch wheelbase, 2½ ton M46 chassis. The van for the process camera section has a similar body with an additional 3-foot expandable rear compartment.

c. All vans contain the following standard items of equipment: an air-conditioner-heater unit, a communications system (portable field-phone type), an overhead fluorescent lighting system, and blackout screens on the windows. Exterior wheel racks are mounted on either side of the vans for storage of an electric power cable and a water hose. See figures 10–1 and 10–2 for curbside and roadside views of a typical reproduction train van.

d. The engineer topographic battalion train consists of six types of vans. The engineer topographic company train uses only five of the six types. The different types are as follows:

(1) Process camera van.

(2) Photomechanical van.

(3) Layout van.

(4) Plate processing van.

(5) Press van.

(6) Headquarters and laboratory van. (This van is included in the battalion train, but normally is not part of the company train.)

e. The interior arrangement of each type of van is illustrated in figures 10–3 through 10–8.

f. The vans which make up the map reproduction train are described in (1) through (6) below.

(1) The process camera van (fig. 10–3) is divided into two sections by a double door light-tight partition. The larger section contains the front end of the 24- x 30-inch copying camera, *a*, with its two attached arc lamps; the copying board: and two water tanks, *c*. The smaller com-

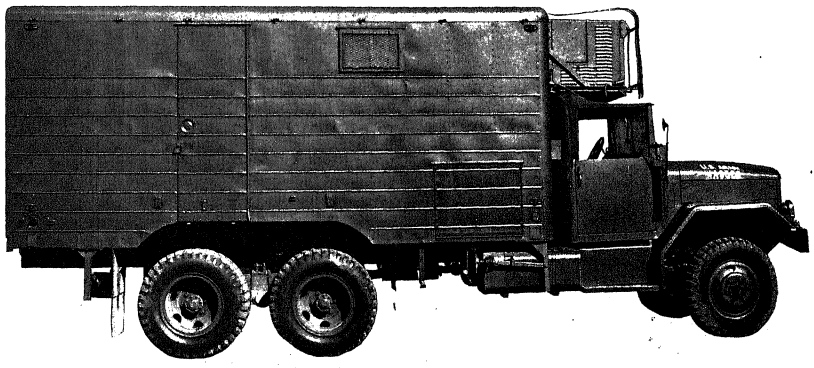


Figure 10–1. Map reproduction van (curbside view).

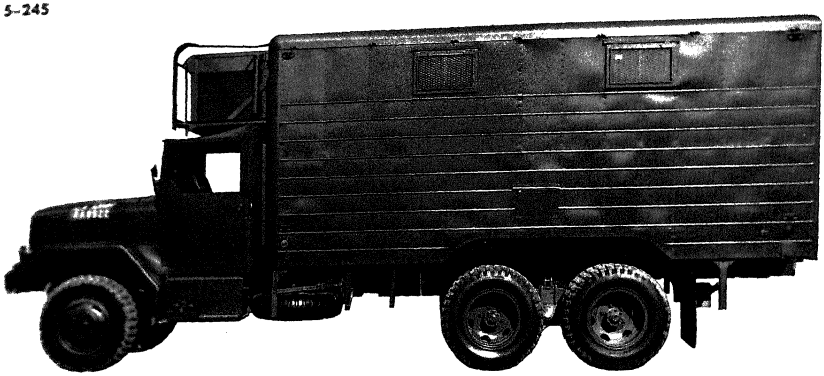


Figure 10–2. Map reproduction van (roadside view).

[illegible], which serves as a darkroom, holds the [illegible] camera plus a wall-mounted light box, [illegible] negatives; and a temperature-con[illegible] processing unit, *d*. The rear por[illegible] expanded 3 feet to provide additional [illegible] space for the photographic darkroom [illegible] operations, the temperature-con[illegible] processing unit is located in this [illegible] the van is to be moved, the processing [illegible] in a position directly behind the [illegible] back. The expandable rear is [illegible] and locked.

[illegible] layout van (fig. 10–4) contains the [illegible] of equipment: one precision lay[illegible] table, *a*; three opaquing tables [illegible] light tables), *b*; and one map cabi[illegible] equipment in this van is sufficient to [illegible] work load of the mobile layout [illegible] excessive load develops, the layout [illegible] other vans also can be used.

[illegible] photomechanical van (fig. 10–5) is [illegible] facilities for rub-on color [illegible] the preparation of "blueline im[illegible] material. This van is equipped [illegible] items: a temperature-con[illegible] processing unit, *a*; a lithographic [illegible] lamp, *c*; a vacuum frame, *d*; two [illegible] tables, *e*; and a 5-drawer cabi[illegible] piece of equipment included [illegible] and model brush graining instru[illegible] plates, to assist the plate [illegible]

[illegible] plate processing van (fig. 10–6) contains the following pieces of equipment: a vacuum frame with attached vacuum pump, *a;* a rail-mounted arc lamp, *b*; two lithographic sinks, *c*; three cabinets, *d* and *e*; one tilt-top opaquing table, *f*; one centrifugal water pump (included in the TOE, but usually located in this van) for use by the entire train, *g*; a wall-mounted lithographic plate rack, *h*; a refrigerator for the storage of chemicals, *i*; and two overhead water tanks to supply the sinks, *j*. Also included in this van, but not illustrated in figure 10–6, is a hand model brush graining instrument. A curtain is mounted in the van to protect the personnel from possible eye damage resulting from overexposure to the ultraviolet rays from the carbon arc lamp.

(5) The press van (fig. 10–7) is equipped with an ATF Model DP press, *a*; two press roller cabinets, *b*; a lithographic press cabinet, *c*; and two lithographic paper tables, *d*.

(6) The headquarters and laboratory van (fig. 10–8), in the battalion, but not the company train, is used as the operations section. It also serves as a central photolithographic laboratory. The operations section uses the following items of equipment: a typist's desk, *a*; a field telephone switchboard, *b*; and a 5-drawer filing cabinet, *c*. The equipment for the laboratory portion of the van includes: a lithographic sink, *d*, complete with an overhead, 65-gallon water tank, *e*; a refrigerator, *f*, for storage of chemicals and other supplies at low temperatures; two tilt-top light tables, *g*, for negative editing, opaquing, and layout work; and cabinet space, *h* and *i*, for office and laboratory supplies.

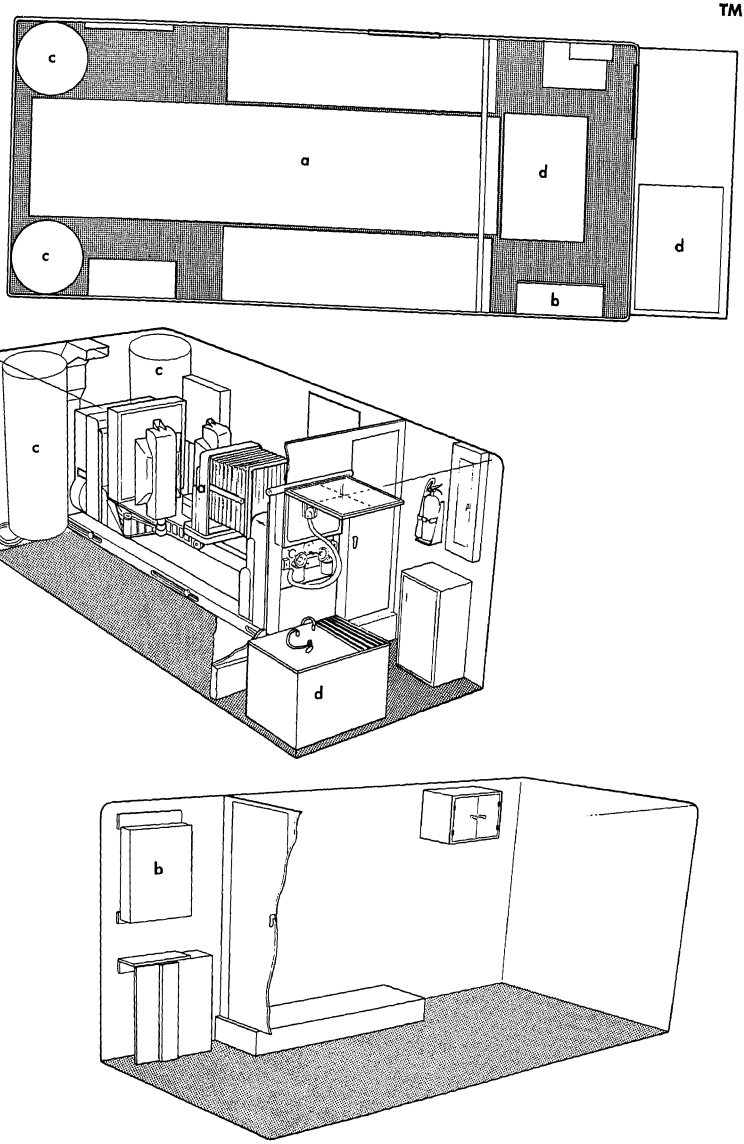


Figure 10–3. Interior arrangement of process camera van.

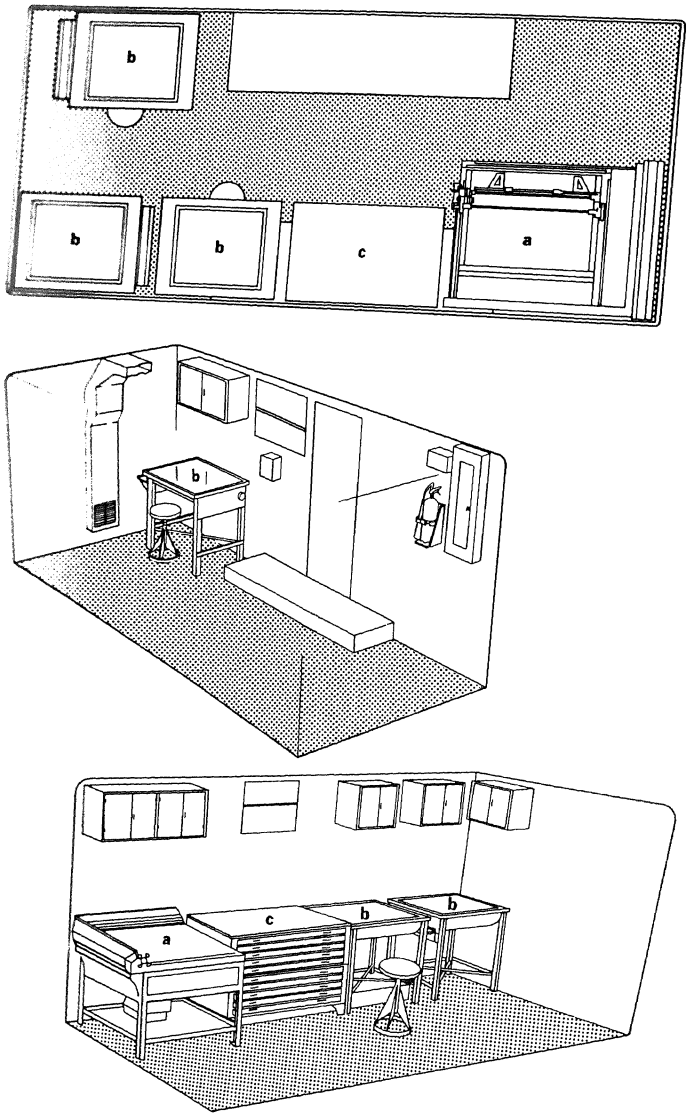
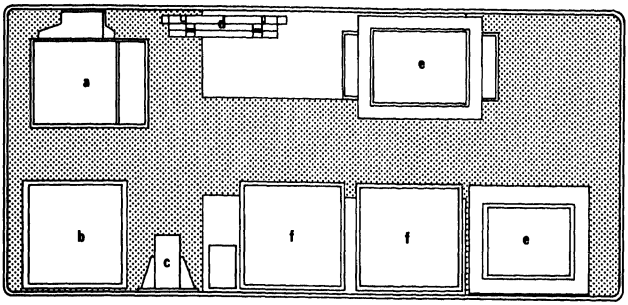


Figure 10-4. Interior arrangement of layout van.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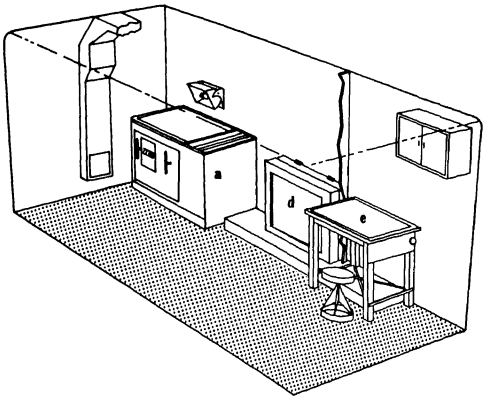
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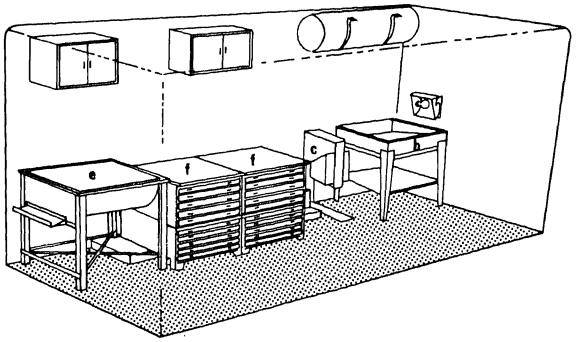
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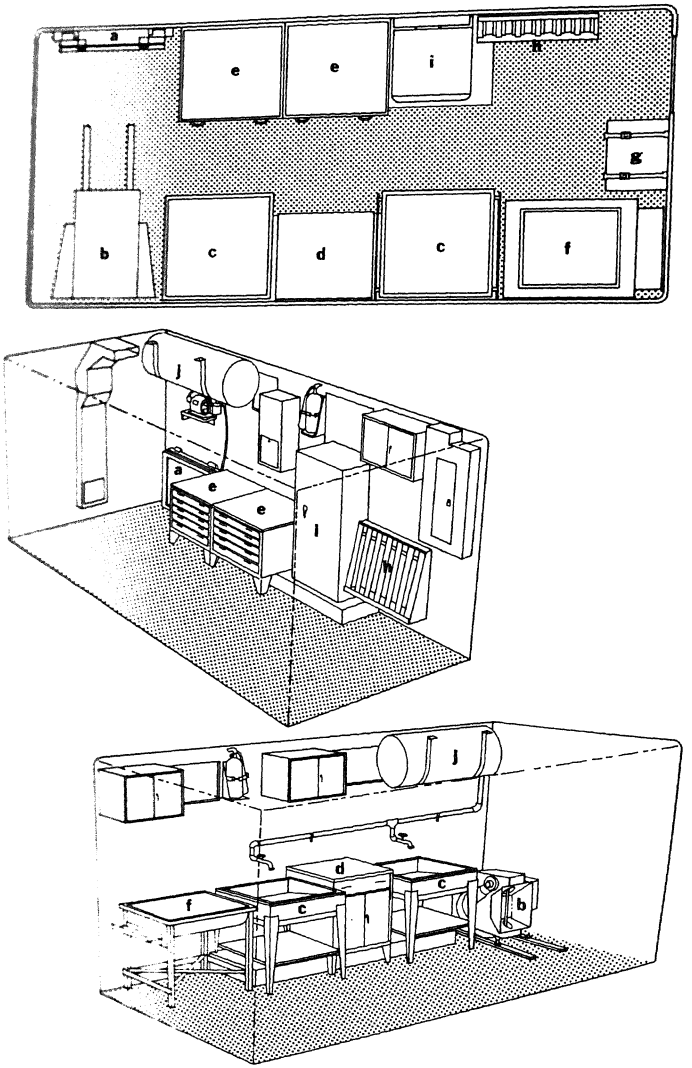


Figure 10–6. Interior arrangement of plate processing van.

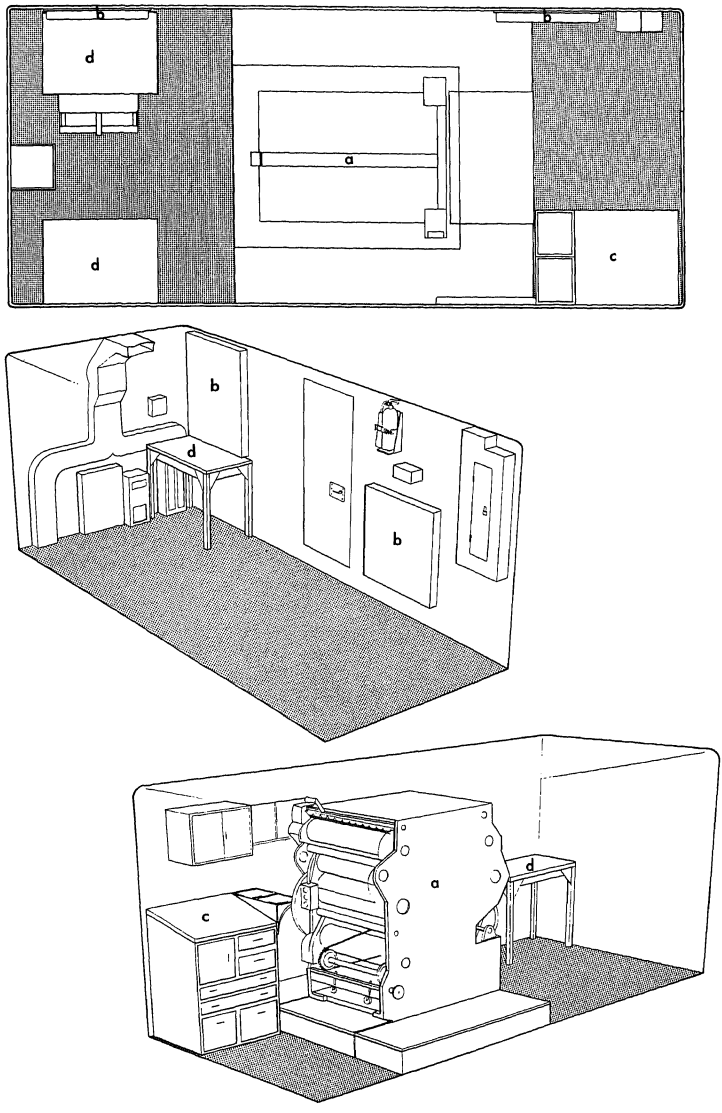


Figure 10–7. Interior arrangement of press van.

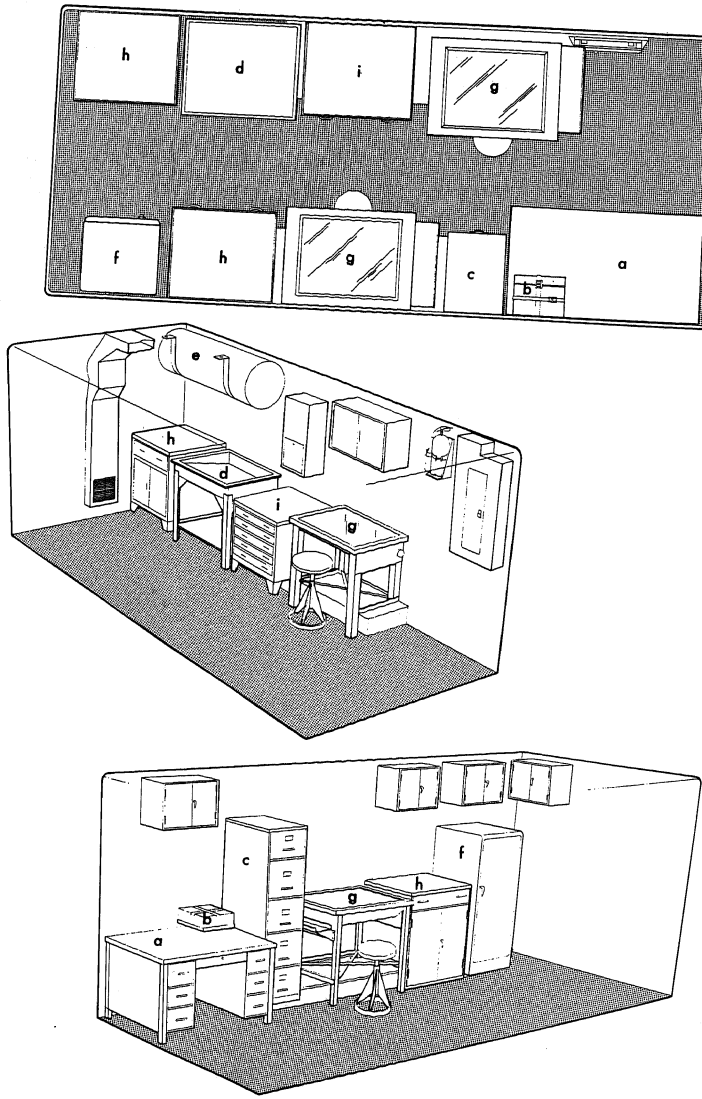


Figure 10–8. Interior arrangement of headquarters and laboratory van.

10–2 Selecting Field Site for Operation

a. Considerations. Several factors must be considered when selecting a field site for the map reproduction train. These fall into two categories —tactical, which are universal for van operation; and technical, which are requirements for the map reproduction train. The first category includes accessibility, concealment, cover, defense, communications, and terrain suitability. The technical considerations require knowledge of soil conditions, van dispersal, availability of usable water, and humidity and temperature conditions. These factors are interrelated and must be considered simultaneously. They are not listed in any order of preference.

b. Tactical. The selected site must allow for the proper location of the vans to perform their operation efficiently. FM 30–10 discusses in detail the tactical elements which can affect the operation.

(1) *Accessibility.* The train must be able to reach the location with little difficulty. Provisions should also be made for a possible withdrawal and movement to a new site (FM 55–30).

(2) *Concealment.* The site should be adaptable to natural cover for camouflage (FM 5–20). It should be as invisible as possible to ground and air observation. Netting and garnish material can be used, but natural cover is preferable. Wooded areas can provide the concealment, but must be open enough to permit the maneuvering of the vans in setting up.

(3) *Cover.* Protective cover should be considered. The effectiveness of the different types of cover (FM 5–15) and the placement of the vans to achieve the best use of this cover are two more factors.

(4) *Defense.* Tactics require provision for possible defense of the train and the surrounding area. FM 5–146 explains these requirements.

(5) *Communication.* Access to a higher, lower, or adjacent headquarters is a consideration in site selection. Signal communication may be used as a supplement to direct access, but map reproduction requires personal contact in many of its phases.

(6) *Terrain suitability.* Unstable climate, and infested and unsanitary areas would detract from the efficiency of the operation, and should be avoided. Mountainous, desert, or marshy locations also present tactical problems (FM 30–10).

c. Technical. Selection of the proper site must also consider the requirements associated with the map reproduction train.

(1) *Soil conditions.* The soil must support the weights of the individual vans in place. Since the vans also require lateral leveling (by built-in jacks), the ground must be fairly level.

(2) *Van dispersal.* Each group of three vans is dependent upon one 60-kw generator for a power source. Since the maximum length of electric cable for efficient power distribution is 100 feet (about 30 meters), each van in the group must be placed no farther than this distance away from its power source. See figure 10–9 for a possible layout of an engineer topographic company's map reproduction train in the field.

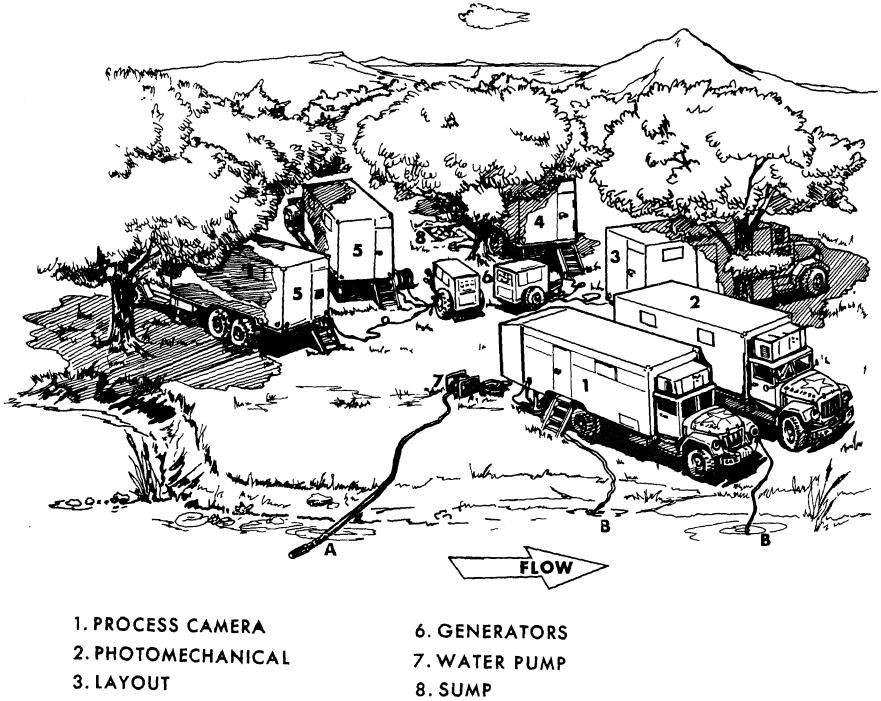
(3) *Usable water.* Photolithographic map reproduction requires water for its operation. However, not all water is suitable. The source may be contaminated with impurities, both solid and chemical, that make it impractical to use. Disposal of the waste must also be considered.

(*a*) *Impurities.* The water source may contain solids, such as debris, organic matter, and sand, and chemical impurities, either dissolved or in suspension in the water. The chemicals can cause fogging, scumming, or precipitation of other chemicals in the solutions. The lack of chemical balance is the most common fault. These impurities must be removed or an alternate supply of water furnished for the lithographic operation. The local water may be adequate for washing up.

(*b*) *Filtering.* After the debris and solid matter have been screened, the water must be filtered and chlorinated. Allow the water to stand in the canvas tank to settle out some of the impurities. Filter through available filters or improvised pads of cheesecloth with squares of absorbent cotton between until the water is comparatively clear.

(*c*) *Chemical balance.* Almost all lithographic solutions are acid and require a specific pH for proper operation. The mixing formulas are based on neutral water and the quantity of acid to be added to achieve the pH. To eliminate changing formulas after every move, a water purification set is included in the unit's equipment. This set can be used not only to purify the water but also to balance it chemically.

(*d*) *Water lines.* With the water purifica tion system provided, chlorinating and filterin minimize difficulties caused by suspended matte and growth of algae in pipes and tanks. Pump



1. PROCESS CAMERA
2. PHOTOMECHANICAL
3. LAYOUT
4. PLATE PROCESSING
5. PRESS
6. GENERATORS
7. WATER PUMP
8. SUMP
A. WATER INTAKE
B. DRAINAGE (DOWNSTREAM FROM SOURCE)

Figure 10-9. Possible layout of map reproduction train.

tanks, and the circulating system within the mobile units must be drained where freezing conditions are expected.

(*e*) *Storage.* If the unit's stay is to be an extended one, it might be practical to erect a tower with canvas storage tanks to provide a gravity flow of water to the vans. For short stays, or constant moving, a water truck or trailer may be more conveinent to use.

(4) *Drainage.* When planning a drainage system for a map reproduction van that has been camouflaged, care must be taken to see that the water does not give away the position of the truck to an enemy observer. Even though the water draining from the van is heavily laden with chemicals, it will still irrigate the ground and may cause the grass and weeds to grow green and lush. Most chemicals support, and often encourage, the growth of plants and even animal bacteria. The only chemicals used that will kill plant life outright are extremely acid or alkaline solutions containing agents such as hydrochloric acid and sodium hydroxide. If these two agents flow together, however, they will tend to neutralize each other.

(*a*) *Disposal in dry country.* When working in semiarid or desert areas, it is especially important that the waste water be disposed of in such a way that it will not cause any breach of camouflage. A good way to dispose of waste water in these areas is to dig a large pit, fill it with large boulders or rocks, and build a cover that can be camouflaged to look like the surrounding area. A

hose or pipe can be used to carry the waste water into the pit and the natural porosity of the ground will take care of the drainage.

(*b*) *Sanitation.* Two other reasons for disposing of the waste water in an acceptable manner are sanitation and cleanliness. Mud holes do not contribute to clean working conditions. When water collects in small pools, insects use these places as breeding areas. If such pools develop near the vans, take immediate measures to drain them and lessen the hazard of an increased insect population in the locality.

(5) *Humidity and temperature conditions.* Each van is equipped with an air-conditioner-heater unit which controls the temperature and humidity inside. However, the normal flow of work requires that paper, film, or metal plates be transferred from one van to another. Exterior humidity and temperature can thus affect the materials each time they are transferred to another van, especially if the vans are set the maximum distance apart. This may require placing the material in special containers or wrappings each time. Another solution is to set the vans so that a cover, canopy, or chute could be constructed between the doorways to minimize the effects of the weather on the materials.

10–3. Leveling Vans

Leveling jacks are provided at the four corners of the van body (fig. 10–10—10–13). These jacks are bolted to the underside of the van body and can be retracted when the vans are to be moved. They are designed for *lateral* leveling of the van and obtaining stability of the equipment. Precise longitudinal leveling of the vans is not required for technical operation. If desired, longitudinal leveling can be obtained by proper site selection or by digging out or blocking up the wheels. To level the van laterally, the jacks are adjusted by means of ratchet handles until the small bubble of each level is centered. DO NOT LIFT THE TIRES OFF THE GROUND. The leveling jacks are *not* designed for raising the truck wheels off the ground.

10–4. Semipermanent, Garrison-Type Location in the Field

When the map reproduction train is set up for semipermanent operations in the field, the ideal type of location is a large garage, a warehouse, or similar industrial or commercial building. The vans can be brought in under a roof or backed up

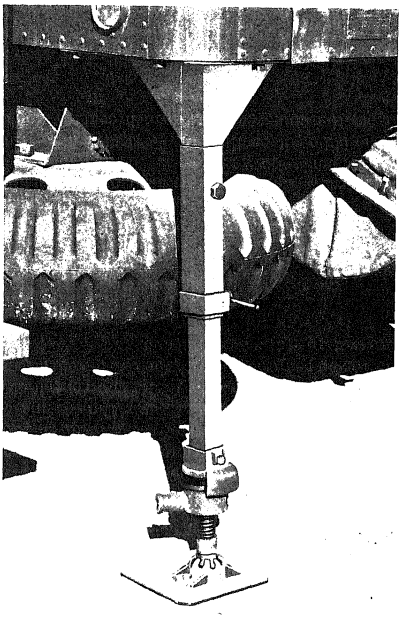


Figure 10–10. Roadside, forward leveling jack in down position.

to the loading platform outside the building. Figure 10–14 illustrates one possible layout of vans inside an industrial building. A platform or ramp

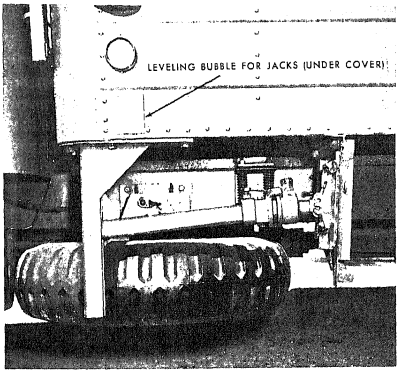


Figure 10–11. Roadside, forward leveling jack in raised position.

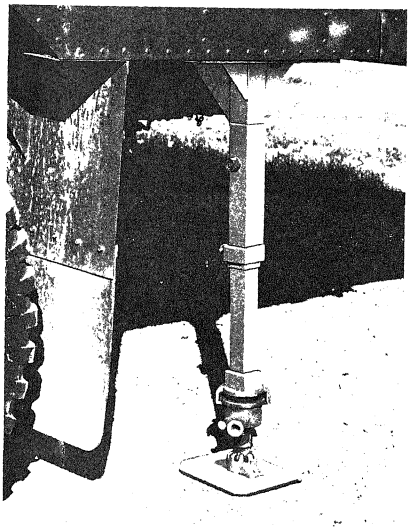


Figure 10–12. Roadside, rear leveling jack in down position.

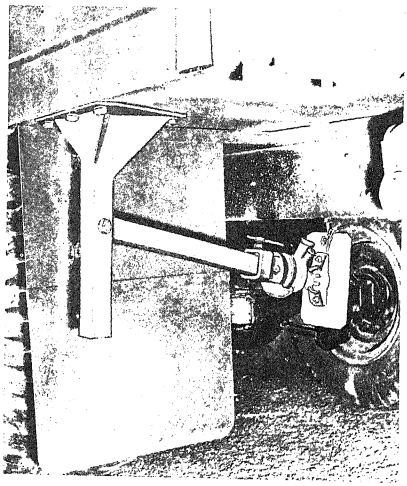


Figure 10–13. Roadside, rear leveling jack in raised position.

built up to the floor level of the vans greatly facilitates the flow of materials from one van to the next.

10–5. Capability and Characteristics of Equipment Common to all Reproductions Vans

a. Electric Power. The reproduction train requires a 208-volt, 3-phase, 4-wire current for electric power. This may be produced by the 60-kw generator (three for a topographic company; three for a battalion), or procured locally. A receptacle is located on the curbside of the van body near the rear for plugging in the power supply (fig. 10–15). Duplex outlets are located on the interior side walls for 115-volt appliances. Light switches, inside the side door, control both the 24-volt emergency lights and the fluorescent ceiling lights. Individual pushbuttons on each fixture allow operation of either one, two, or three tubes. Inside the panel board is a chart showing the various circuits and the color coding of each. Also shown is the 24-volt wiring. The initial electrical hookups normally are done by well qualified electricians, and they should train the other operating personnel. When using the 3-phase, 4-wire system, care must be taken to insure that the motors rotate in the proper direction.

b. Reel Racks. Power is conveyed from the generators and transformers by 100-foot, multi-conductor, heavy-duty electrical cables. When the cables are not in use, they are stored on large reels underneath the van body. Canvas covers keep them dry and clean.

c. Blackout Window Screens. The van body is designed to be light-tight inside even under direct sunlight, and light-tight outside when the inside lights are on during blackout conditions. The blackout screens on the windows slide up and down as needed. The windows can be swung out for cleaning.

d. Telephone Connection. An outside plug-in for the telephone wire is located on the curbside just to the rear of the side door. Terminals are available inside for attaching portable field telephones.

e. Air-Conditioner-Heater.

(1) To operate the air-conditioner-heater, be sure the exhaust pipe is raised before operating the heater. The fuel supply valve located at the bottom of the tank and the valve on the electric fuel pump in the compartment on the roadside of the van should be closed when the heater is not in

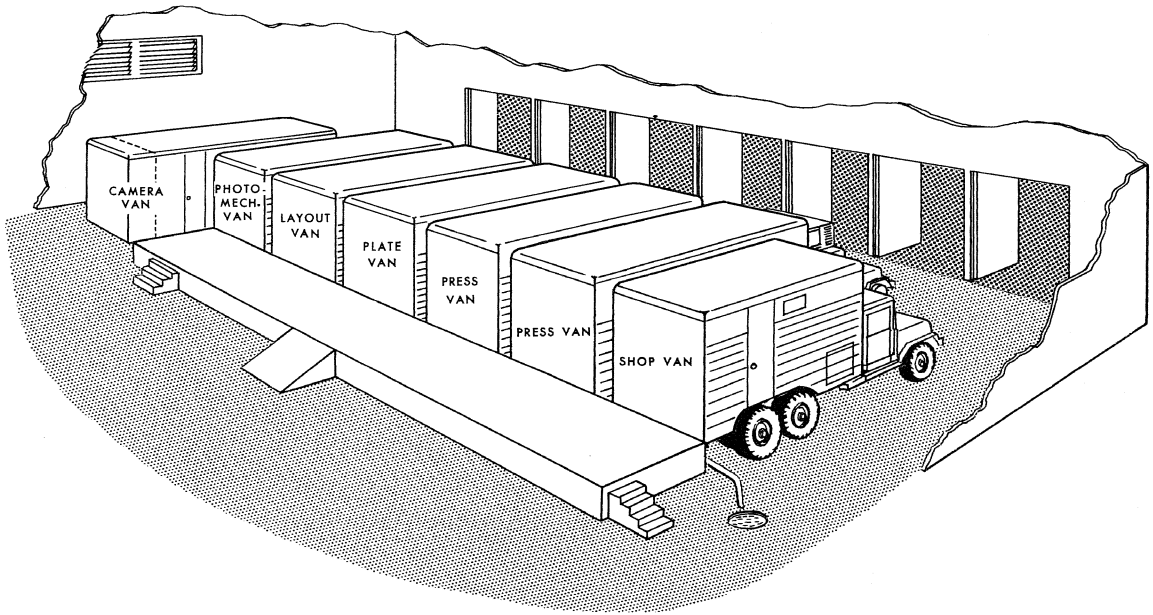


Figure 10–14. Possible garrison layout of map reproduction train indoors.

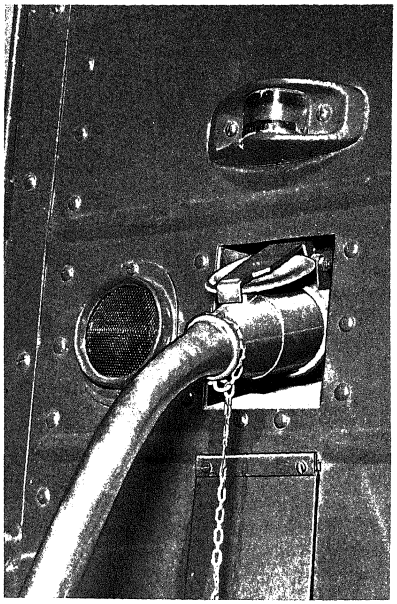


Figure 10–15. All-weather electric power receptacle.

operation. The quadrant damper can be adjusted to deflect warm or cool air to the ceiling duct.

(2) The air-conditioner-heater is designed to fit in the van body space above the cab. It has ducts connected to the air-conditioned space. Controls are in the van. In operation, space air is drawn through the inlet duct in the rear of the unit, conditioned, and then discharged through the outlet duct to the controlled space. Fresh air is introduced, when desired, by opening the damper in the bottom of the evaporator compartment. The unit provides three types of conditioning-ventilation only, ventilation and heating, and ventilation and cooling. The unit is placed in operation by snapping the master switch to the ON position. This will start the circulating fan which runs while the master switch is ON. The compressor or heater cycle can then be turned ON and OFF, depending on the operation desired.

(3) Operation of the unit is controlled by thermostats mounted on the van wall. The type of operation is set by the three-position switch on the control box. Each of the different positions gives the following:

(*a*) *Cooling.* The compressor starts and tops on thermostatic demand. A change in temperature of 2° will cycle the unit ON to hold a desired temperature.

(*b*) *Ventilation.* The circulating fan continuously recirculates the air. If the damper in the bottom of the evaporator compartment is open, it introduces fresh air.

(*c*) *Heating.* The heater is started manually, and then is controlled by the heating thermostat. It will cycle to maintain the duct temperature at 75°. During operation, the heater uses gasoline, drawn from the truck fuel tank, at the rate of 1 gallon per hour.

f. Water Storage Tanks. In some of the vans, there are 65-gallon water tanks. A gasoline-driven water pump is included in the TOE for use by the whole reproduction train. A water purification set makes the water suitable for photographic and lithographic use. The tanks *must* be emptied before the vans are moved, and also if freezing weather is expected.

10–6. Preparing Vans for Movement

a. Load sufficient supplies and materials in the vans to permit the section to continue operation at the new area or site until the supply channels function again.

b. Bottle and store in the vans, as far as practical, any solutions and compounds, such as gum arabic, which require time to prepare to a ready-to-use state. This will enable the section to start work almost upon arrival at the new area.

c. Roll up exterior items, such as water hoses, electric cables, and camouflage netting, and pack them to accompany the van.

d. Lock in place or otherwise fasten down the vacuum frame, the arc lamp, and similar items of equipment to prevent any damage during transit. Remove all removable rollers from the press and secure them in the rack.

e. Drain the water tanks, unless they are needed as a water supply in the new area. This could be due to a water shortage, or to the presence of impurities which require extensive treatment to remove.

f. Retract the leveling jacks and fasten them securely.

g. Place a cover over the plates in the plate rack and bind it to prevent the plates from sliding and being scratched.

h. Return any uncompleted jobs to reproduction headquarters, unless orders to the contrary are given.

i. When all else is completed, close and lock the doors to the vans.

j. Report to reproduction headquarters, that the vans are ready to move.

k. Time permitting, make a final check of the area to insure that any items of equipment, such as shovels or ground rods, are not left behind. Fill in holes or trenches and try to restore the area to an undisturbed appearance.

10–7. Setting Up Vans for Operation

a. Place the vans in the designated positions.

b. Camouflage the vans and the drainage areas. (The vans using large quantities of water must select an area which permits the digging of drainage facilities.)

c. Level the vans laterally.

d. Connect the electrical cables and water hoses.

e. Check equipment and solutions.

f. Report to reproduction headquarters when ready for operation.

APPENDIX A
REFERENCES

A–1. Army Regulations

AR 117–5	Military Mapping and Geodesy.
AR 310–1	Military Publications (General Policies).
AR 310–3	Military Publications (Preparation, Coordination, and Approval).
AR 310–25	Dictionary of United States Army Terms.
AR 320–50	Authorized Abbreviations and Brevity Codes.
AR 345–20	Release of Information and Records from Army Files.
AR 360–5	General Policies.
AR 380–5	Safeguarding Defense Information.
AR 725–50	Requisitioning, Receipt and Issue System.

A–2. Department of the Army Pamphlets

DA Pam 108–1	Index of Army Motion Pictures, and Related Audio-Visual Aids.
DA Pam 310–1	Index of Administrative Publications.
DA Pam 310–3	Index of Doctrinal, Training, and Organizational Publications.
DA Pam 310–4	Index of Technical Manuals, Technical Bulletins, Supply Manuals, Supply Bulletins, and Lubrication Orders.
DA Pam 310–7	U.S. Army Equipment Index of Modification Work Orders.

A–3. International Standardization Agreements

2202	Map Conventional Signs.
2203	Map Reference System to be Used in the Target Area in Close Air Support Operations.
2204	Maps to be used in Close Air Support Operations.
2205	Use of Identical Maps by NATO Ground Forces (SEATO).
2206	Standard Scales for Maps Affecting Land Operations.
2207	Standard Sheet Sizes for Maps of Various Scales.
2209	Edition Designation System for Land Maps.
2210	Trig Lists.
2211 (2d Ed)	Geodetic Datums, Spheroids, Grids, and Grid References.
2212	Map Series Numbering.
2213	Indexes to Names on Land Maps.
2214	Marginal Information on Land Maps.
2215	Evaluation of Land Maps.
2216	Vertical Aerial Cartographic Photography.
2217	Sizes of Indexes to Series of Land Maps.
2218	Military City Maps.
2251	Scope and Presentation of Military Geographic Information and Documentation (MGID).

2262	Presentation of Military Geographic Documentation.
3178	Rolled Air Film and Air Camera Format Sizes.
3179	16-MM and 35-MM Roll Film for Airborne Cameras.
3180	Sheet Photographic Paper.
3182	NATO High Contrast Developer.
3187	Labeling of Prepackaged Photographic Chemicals.

A–4. Field Manuals

FM 5–1	Engineer Troop Organizations and Operations.
FM 5–15	Field Fortifications.
FM 5–20	Camouflage.
FM 5–25	Explosives and Demolitions.
FM 5–30	Engineer Intelligence.
FM 5–146	Engineer Topographic Units.
FM 7–10	Rifle Company, Infantry, Airborne, and Mechanized.
FM 21–5	Military Training Management.
FM 21–6	Techniques of Military Instruction.
FM 21–26	Map Reading.
FM 21–30	Military Symbols.
FM 21–31	Topographic Symbols.
FM 30–10	Terrain Intelligence.
FM 55–30	Army Motor Transport Operations Units.
FM 101–10–1	Staff Officers' Field Manual: Organization, Technical, and Logistical Data.

A–5. Technical Manuals

TM 5–230	General Drafting.
TM 5–240	Map Compilation, Color Separation, and Revision.
TM 5–243	Cartographic Aerial Photography.
TM 5–244	Multiplex Mapping.
TM 5–248	Foreign Maps.
TM 5–3610–200–25P	Organizational, Direct and General Support, and Depot Maintenance Repair Parts and Special Tool Lists: Printing press, Proof: Offset, Floor Mounting. (Rutherford Machinery Model 2.)
TM 5–3610–202–15	Operator, Organizational, Field and Depot Maintenance Manual: Printing Press, Offset, Cylinder-rotary; (ATF Model DP).
TM 5–3610–202–20P	Organizational Maintenance Repair Parts and Special Tool Lists: Printing Press, Offset; ATF Model DP.
TM 5–6001	Camera, Overhead, Darkroom Copying, Complete With Accessories (40 x 40-inch).
TM 5–6007	Camera, Copying, Mobile Process (24 x 30-inch).
TM 5–6030	Press, Proving, Lithographic Offset.
TM 11–401	Elements of Signal Photography.

Technical Bulletins

TB Sig 345	Instructions for use of Paper, Photographic, Sensitized, Variable Contrast.

A–7. Miscellaneous Publications

TOPOCOM Bulletins and Technical Instructions, U.S. Army Topographic Command, Washington, D.C. 20315.

The Lithographers Manual, and complete series of Technical Publications, Graphic Arts Technical Foundation, 4615 Forbes Avenue, Pittsburgh, Pa. 15213.

Manual of Photogrammetry, Vols. I and II, American Society of Photogrammetry, 6269 Leesburg Pike, Falls Church, Va. 22044.

Navy Training Course, Lithographer I&C (NAVPERS 10454–A) and Lithographer 3&2 (NAVPERS 10452A), Bureau of Naval Personnel, Columbia Pike and Arlington Ridge Road, Arlington, Va. 20370.

AF Manual 95–13, Vols. I and II, Principles and Practices for Precision Photographic Processing Laboratories, Air Training Command, Randolph Air Force Base, Tex. 78148.

APPENDIX B

NEGATIVE DIFFICULTIES, CAUSES, AND REMEDIES

Difficulty	Cause	Remedy
1. Image does not develop	*a.* Negative not exposed	Check lens, shutter, and camera lamps for failure to operate properly.
	b. Developer oxidized	Replace with fresh developer.
	c. Developer too cold	If temperature is too low, developer does not function. Heat to 68° F.
2. Develops too slowly	*a.* Negative underexposed	Check lens-diaphragm opening and coverage of arc lamps. Allow for filter factor, color of copy background, and halftone screen. Increase exposure time.
	b. Developer cold	Increase temperature to 68° F.
	c. Developer old	Usually indicated by brown color and slow action on exposed test strip. Drain developer, clean tray or tank, and replace with fresh developer. If developer ages too quickly, impurities in water may be cause. When doubtful, use distilled, rain, or boiled water for developer.
3. Develops too quickly	*a.* Overexposed	Check diaphragm opening and position of lamps. Correct condition or reduce exposure time.
	b. Developer too warm	Lower temperature to 68° F., if possible. Otherwise, reduce developing time, dilute developer, or develop by inspection.
	c. Negative fogged	Indicated by general darkening of negative in unexposed areas. May be caused by accidental exposure or too much light in darkroom. Heat, chemical fumes, and age also cause fogging. Correct cause and remake negative. Slightly fogged negatives may be corrected by using Farmer's reducer after fixing.
4. Does not clear in fixer or clears too slowly.	Fixer old or spent	Replace with fresh solution.
5. Negative veiled or fogged in clear areas.	*a.* General	A clearing bath (Farmer's reducer) frequently make fogged, overexposed, or overdeveloped negatives satis factory for use. It also clears halftone negative developed under conditions contributing to fog.
	b. Overexposure	Reduce exposure so image first appears in required tim (30 to 45 seconds for photo-mechanical film at 68° F.
	c. Overdevelopment	Develop only for required time. Reduce time for ten peratures above 68° F., or develop by inspection.
	d. Developer old	Indicated by prolonged development. Replace develope
	e. Poor copy	Black lines or type on copy are gray or broken. Slig underexposure sometimes helpful. Clear after fixing.
	f. Light reflection from arcs into lens	Adjust lights to eliminate undesired reflections.
6. Negative not developed	Uneven action of developer	Immerse negative into developer uniformly and rapid Agitate developer frequently. Prevent air bells fr forming.
7. Negative grained or reticulated	Temperature variations	Keep developer, water, fixing baths, and room at sa temperature to prevent reticulation. Some films quire special developers for temperatures above 80°
8. Negative lacks density	Underexposed or underdeveloped.	See item 2 above.
9. Negative thin in corners	Illumination not uniform	Usually due to falling off of light intensity on corner large copy. Increase distance of lights to copy, use fusers, or improvise large white cardboard reflec

Difficulty	Cause	Remedy
		below and above copyboard to reflect light onto edges of copy. May also be due to exposure with lens wide open. Stop down to f/22 or f/32 for line shots.
10. Blurred image	*a.* Out of focus	Check image on ground glass. See that copy board ground glass and vacuum back are locked in exposure position. Also, check scale readings if camera was positioned to scale. In critical focusing, check with lens stopped down to that required for exposure, because focal length may vary with diaphragm opening. When using filters or screen focus with filter or screen in position. If focal length of lens seems to have altered, have qualified operator check inner and outer elements of lens to make certain they have not loosened.
	b. Movement	Vibration transmitted to camera may blur fine detail. During exposure, reduce movement around camera to minimum. Check film movement on vacuum back; recheck focus—lens board may have moved.
11. Halftone negative, incorrect contrast. The opaque dots in the denser areas (highlights) overlap (no clear dots remain) and the opaque dots in the light areas (shadows) are too small. Negatives of this type produce plates in which the small dots are missing in the highlights, while the shadows are solid and lack detail. Also, fogged highlight dots and shadow dots that are too small or too weak.	*a.* Screen in too far from the sensitive material.	Check the screen distance with calibrated wedge.
	b. Overexposure with the highlight stop.	Decrease the highlight exposure.
	c. Highlight stop is too large	Use a highlight stop which bears a closer relationship to that specified by the screen equation.
	d. Failure to use a flash exposure	Using a small diaphragm aperture, flash the negative by placing a piece of enamel-coated white paper over the copy.
	e. Tonal range of the copy is too great.	Make an additional exposure with a small stop or increase the detail exposure which may have been insufficient.
12. Halftone negative, incorrect contrast. Either the opaque dots in the denser areas (highlights) are too small (the clear dots too large), or the opaque dots in the light areas (shadows) are too large, or both. A negative of this type is termed "flat."	*a.* The stop used for the highlight exposure is too small.	For average halftone made with two stops and a flash, the highlight stop should bear the relationship of 1:44 to the camera extension. With weak lights or slow sensitive materials, it is impossible to use a stop whose relation is 1:38 or 1:32 to the camera extension.
	b. The screen distance is too short.	Examine the screen setting and distance. Refer to paragraph for the correct screen distance for the screen in use.
	c. Insufficient highlight exposure.	Highlights which are too open because of insufficient exposure must be judged more carefully. If one stop and a flash exposure were used, it is possible that the stop was too small. If a highlight and detail and a flash exposure are given, the highlight expsosure may require additional time. With the three-stop method, the middle-tone exposure affects the highlight dots to some extent, so a slight increase of the middle-tone exposure may be all that is necessary to decrease the size of the highlight dots. An increase of the highlight exposure will, however, be more effective.
	d. The detail and flash exposure are too long.	Decrease the detail and flash exposure duration.
	e. The flash stop was too large	Make the flash exposure with a small round diaphragm aperture whose relations to camera extension is between 1/128 and 1/256.
13. Halftone negative, incorrect dot formation. Dots have soft edges. Such dots will not produce satisfactory press plates as light readily penetrates them. Fuzzy dots are also incapable of holding light back and thus	*a.* Screen distance too long	Obtain correct screen distance for the screen in use.
	b. Incorrect stop or stops	Stops should be of a size proportional to the camera extension.
	c. Halftone screen and sensitive material are not parallel.	Check the parallelism of the planes of the camera extension.
	d. Underdeveloped negative due to insufficient developing time or worn out or oxi-	Develop according to the manufacturer's instructions. Use fresh developer. Pour out and dilute enough developing solution to fill the tray 1 or 2 inches deep just

Difficulty	Cause	Remedy
form larger printing dots on the press-plate.	dized developing solution.	before use. For single halftone negatives, use fresh developing solution for each negative. When developing batches of negatives at one time, use fresh developer for each 6 to 10 negatives. The rate of deterioration of the developer depends upon its use and its exposure to the air. The discoloration of the developer indicates the degree of oxidation.
	e. Temperature of developing solution is too low.	Developer temperature should be 65° to 70° F., or 18° to 21° C.
14. Halftone negative, incorrect dot information: square shadow dots and square transparent highlight dots.	a. Screen distance is too short	Recheck the screen distance.
	b. Stops are too small	Use a larger set of stops.
	c. Flash stop too large and exposure too long.	Use a smaller stop for flashing. Shorten the flash exposure.
15. Halftone negative, transparent dots are fogged.	a. Exposure to extraneous light	Use the proper safelights for the sensitive material in use. Use sensitive materials prior to the date of expiration. See that the container of sensitive material is light-tight. Close all cracks through which light can enter the darkroom.
	b. Lack of bromide in the developer.	Compound the developing solution strictly according to formula.
16. Halftone negative, double dots.	a. Camera vibration during the exposure.	Check camera for contact with the wall of the darkroom. Avoid moving the camera or its parts during the exposure. The concussion of air caused by slamming a darkroom door will cause vibration and should be avoided.
	b. Stops are not concentric	See that iris diaphragm functions properly.
	c. Loose stayflat or vacuum back.	See that the stayflat and vacuum back are stationary.
	d. Halation, or light reflected from the back of the material.	Use antihalation sensitive materials. Cover shiny spots on the vacuum back with dull black paint; also the camera back.
17. Halftone negative, moiré	Screened copy photographed with screen of different ruling or at incorrect screen angle.	The moiré pattern can be diminished and often removed by changing the angle of the screen or changing the position of the copy, if the screen cannot be rotated.
18. Halftone negative, variation in dot size and shape from one side of the negative to the other.	a. Improper alinement of the screen with the vacuum back.	Check parallelism of the planes of the screen and the sensitive material with a graduated wedge. Check the position of the plateholder bridge of the camera.
	b. Uneven illumination	Check the position of the arc lamps and the evenness of the illumination.
19. Halftone negative, weak, soft dots in the shadows with open highlights.	a. Underdevelopment	Develop the negative for the recommended time at the proper temperature.
	b. Underexposure	Expose the negative with the proper stop, or stops, for the necessary time to produce a satisfactory dense negative.
20. Halftone negative, weak, soft dots in the shadows with correct highlight dots.	a. Improper screen distance	Correct the screen distance.
	b. Failure to flash the negative	Flash for the required time to produce satisfactory shadow dots.
21. Halftone negative, spots, streaks, and blotches.	a. Dirt on the screen or on the sensitive material.	Clean the screen with lens cleaning tissue or a soft chamois. Occasional use of lens or screen cleaning fluid will help remove grease or spots. Remove dust by snapping the back of the film or by brushing with a clean camel's-hair brush.
	b. Uneven immersion in the developing solution.	Developer streaks can be eliminated by more even immersion of the negative in the developing solution.
	c. Too little developer in the tray.	Increase so more even development can be accomplished.
	d. Insufficient agitation during development, especially during the early stages.	Agitation improves the uniformity of the half-tone negative.
	e. Failure to plate the sensitive material flatly on the vacuum back or stayflat.	Lay the sensitive material flat on the vacuum back or brush it flat on the stayflat.

Difficulty	Cause	Remedy
22. Brown negatives	*a.* Wornout or oxidized developer.	Use fresh developer for all halftones.
	b. High temperature of the developing solution.	Develop at 65° to 70° F., or 18° to 21° C.
	c. Underdevelopment in an attempt to compensate for overexposure.	Expose negative correctly.
23. Green-brown negative	Overdeveloped in an attempt to compensate for underexposure. (This does not happen with all developers.)	The time required for development should not exceed 20 to 30 seconds for film when all other conditions are standard. Develop for the recommended time.
24. Image not dimensionally correct.	Copy board and film planes not parallel.	Check vertical and horizontal planes with level. Adjust as necessary.

APPENDIX C
FORMULAS

C–1. Formulas for Process Photography

The basic formulas for photographic processing are contained in TM 11–401. The following formulas have special application in lithographic processing and are intended as a supplement to the basic formulas.

a. D–85 Developer. A high-contrast developer for line and halftone negatives. Add chemicals in order listed, allowing each to dissolve before adding the next. Age solution in a stoppered bottle for 2 hours before using. To use, develop negatives 2 to 3 minutes at 68°F. (20°C.).

Water (about 90° F.)	64 oz (1.90 liters)
Sodium Sulfite (desiccated)	4 oz (114.0 gms)
Paraformaldehyde	1 oz (28.6 gms)
Patassium metabisulfite	150 gr (9.7 gms)
or sodium bisulfite	128 gr (8.8 gms)
Boric acid crystals	1 oz (28.6 gms)
Hydroquinone	3 oz (85.7 gms)
Potassium bromide	90 gr (5.8 gms)
Water to make	1 gal (3.8 liters)

b. Fixing Bath for Minimum Shrinkage of Negative. Add chemicals in order listed, allowing each to dissolve before adding the next. Cool solution at 68°F. (20°C.).

Sodium thiosulfate (fixer)	32 oz (914.3 gms)
or sodium bisulfite	3.6 oz (103.0 gms)
Potassium metabisulfite	4 oz (114.0 gms)
Water to make	1 gal (3.80 liters)

c. Prehardener. For negative development at high temperatures. To use, immerse exposed film in solution for 2 to 3 minutes. Remove film and wash for 1 to 2 minutes in water, then develop normally.

Formalin (40 percent formaldehyde)	1 fluid oz (29.6 ml)
Sodium carbonate (desiccated)	½ oz (14.3 gms)
Water	1 gal (3.80 liters)

d. Intensifier (Monckhoven). Prepare solutions separately, then slowly pour solution A into solution B until precipitate formed is almost completely dissolved. Age solution for an hour before using. Negatives immersed in this solution are intensified and cleared simultaneously. Wash and dry negative following intensification.

(1) *Solution A.*

Sodium cyanide	1 oz (28.6 gms)

CAUTION

Sodium cyanide is both an oral and a skin poison! Keep away from acids because they will combine to form a poisonous gas.

Water	32 fluid oz (1.0 liter)

(2) *Solution B.*

Silver nitrate	1½ oz. (42.9 gms)
Water	32 fluid oz (1.0 liter)

e. Restrainer. Add to high contrast developers to prolong development time and minimize fogging at high temperatures.

Water, about 125° F. (50° C.)	96 oz (2.8 liters)
Sodium sulfate (desiccated)	1½ lb (685.7 gms)
Patassium bromide	1 oz (28.6 gms)
Acetic acid (28 percent)	4 oz (118.3 ml)
Cold water to make	1 gal (3.80 liters)

C–2. Formulas for Lithographic Plate Processing

a. Plate Etch. Plate etch makes the background areas of the plate water receptive by depositing a thin, water receptive film on the grain of the plate. The plate etch solution is prepared from stock solution in the following manner:

(1) To 16 ounces of gum arabic stock solution (*b* below),

(2) Add ¾ ounce of ammonium bichromate stock solution (*c* below).

(3) Then add ⅜ ounce of phosphoric acid (85 percent).

(4) Store in a brown stoppered bottle in a cool, dry, and dark place (not below 46° F.) in order to prevent souring.

b. Gum Arabic Stock Solution.

(1) Gum arabic solution is used after the plate has been developed. It protects the plate

from grease, dirt, and oxidation. It is also used to prepare the plate etch solution. The gum in plate etch acts as a carrier for the chemicals as well as a retarder of action. Depending upon the facilities at hand, the stock solution of gum arabic is prepared as follows:

(*a*) Heat water to just below the boiling point in a stainless-steel vessel. Dissolve gum arabic in the water at the ratio of 1 pound of gum arabic to every quart of water.

(*b*) Stir constantly to dissolve the gum completely and to prevent it from sticking to the vessel. Do not allow the water to get too hot, or the gum will burn and be useless.

(*c*) Strain through 4 to 6 thicknesses of cheesecloth, preferably while still warm, to remove impurities. Adjust the solution to 12° to 14° Baumé when cool (77°F).

(*d*) Add ½ liquid ounce of formaldehyde, phenol, or Dowacide A to each 64 ounces of gum solution to prevent it from souring. If refrigeration is available, this step may be omitted.

(*e*) Store in a brown bottle and keep it in a cool (not lower than 46° F.), dark, and dry place.

(2) If a heating source is not available, the gum solution may be prepared by tying the gum crystals in a cheesecloth bag and suspending the bag in water for 2½ to 3 hours, or overnight, if possible. The same proportion of gum to water is maintained and a Baumé reading between 12° to 14° is desired for the final solution.

c. Ammonium Bichromate Stock Solution. When ammonium bichromate is mixed with gum arabic and phosphoric acid, plate etch results. The latter is used to make the background areas water receptive. Ammonium bichromate stock solution is prepared as follows:

(1) Dissolve 16 ounces (avoir) of ammonium bichromate crystals in 64 ounces of water.

(2) Filter the undissolved crystals through cotton or filter paper.

(3) Test the Baumé and add water until the solution tests 14.2° Baumé at 77°F. If below 14.2°, add small amounts of crystal ammonium bichromate until the Baumé is correct.

NOTE

This solution is approximately 1 part ammonium bichromate to 4 parts water.

APPENDIX D
MAP PAPER

D–1. Technical Characteristics of Paper

a. Wire and Felt Sides. Paper has two sides, the wire and the felt side. The wire side is that side which was in contact with the wire of the paper machine during manufacture. The opposite side is called the felt side. The wire side receives an impression of the pattern of the wire on which the paper was formed. Subsequent treatment during processing tends to smooth out the wire marks and makes the appearance of the two surfaces nearly alike. The differentiation of one side from the other is sometimes very difficult and it may be necessary to use several methods before side determination is made with certainty. The simplest procedure is to fold a sheet of paper and compare the relative smoothness of the two surfaces. The wire side can be identified by the diamond-shaped impressions in its surface. If positive identification cannot be made by simple comparison, dip a piece of the paper in water or a dilute sodium hydroxide solution, drain off the excess liquid and allow the paper to stand for a few minutes. This treatment swells the fibers of the paper and restores the surface texture to nearly that which existed in the paper during manufacture. In this condition, the wire side can be easily identified. Another method is to dry a strip of the paper in an oven at a temperature of 212° F. (100° C.), being careful that both sides of the strip are equally exposed. The paper will curl as it dries, with the direction of curl toward the wire side. The wire and felt sides of paper should always be considered for offset printing. For printing on one side only, best results are obtained by printing on the felt side.

b. Machine and Cross Direction (Grain). Paper has two principal directions. The machine direction or grain direction is the direction of the paper parallel to its movement on the paper machine. This grain is caused by the greater orientation of fibers in the movement direction and the greater tension exerted on the paper in this direction. The cross direction is the paper direction at right angles to the machine direction. Ordinarily there is less variation of paper properties in the machine direction than in the cross direction. In offset printing, it is desirable to cut paper with the long dimension parallel to the machine direction and to feed the sheets into the press with the machine director parallel to the cylinder axis. To determine the direction of grain, wet one surface of a small (approx 2 in.) square of the paper and note the axis of curl, which is always parallel to the machine direction. For some papers it is possible to distinguish between machine and cross direction by tearing the sheet in both directions and noting the direction of curl. The line of tear tends to parallel the machine direction.

c. Basis Weight. Weight is the most common specification of paper as most paper is sold on a weight basis. Basis weight is the weight in pounds of a ream containing either 480, 500 or 1,000 sheets cut to a basic ream size. To establish basis weight, sheets of known area are conditioned under standard conditions and then weighed. From the weight and area of the sheets the equivalent ream weight is calculated. A partial listing of basis weights (based on 500 sheets per ream) and basic ream sizes for different grades of paper are listed below.

Paper	Basic size	Basis weights
Newsprint	24″ x 36″	32 lb
M.F. book	25″ x 38″	30, 40, 50, 60, 70 lb
Offset book	25″ x 38″	50, 60, 70, 80, 90, 100 lb
Litho coated book	25″ x 38″	60, 70, 80, 100 lb
Mimeograph	17″ x 22″	16, 20, 24 lb
Duplicator	17″ x 22″	16, 20, 24 lb
Writing	17″ x 22″	12, 16, 18, 20 lb
Map	17″ x 22″	16, 20, 22, 24, 28 lb
Manifold	17″ x 22″	7, 8, 9 lb
Bond	17″ x 22″	13, 16, 20, 24 lb
Index	25½″ x 30½″	90, 110, 140, 170 lb
Manila and tag	24″ x 36″	80, 100, 150, 200 lb

d. Paper Caliper and Bulking Thickness. The thickness of paper or paperboard is the thickness in thousands of an inch of a single sheet of paper or board. Thickness is determined by calipering individual sheets of paper or board after conditioning. A calipering device having standardized jaw areas and exerting a standardized pressure is

used for this purpose. The thickness of paperboard is expressed as "points", each point being equal to 0.001 inch. For example, paperboard 0.030 inch thick is referred to as 30-point board. Calipered paper thickness must not be confused with bulking thickness which is the average thickness of paper in a stack. The average thickness is determined by dividing the height of a stack of conditioned sheets by the number of sheets in the stack. The bulking thickness usually is somewhat lower than the single-sheet thickness.

e. Tensile Strength. Tensile strength is a measure of the resistance of paper to direct tension, and is a component of the more complex bursting, folding, and tearing strengths. Tensile strength is always greater in the machine direction than in the cross direction due to the greater alinement of fibers in the machine direction. Tensile strength is important in newsprint and other papers printed on a web press where high-tensile strength is needed to resist tension during printing. Frequently the tensile strength is expressed in pounds per inch. This value indicates the force in pounds required to break a strip one inch wide.

f. Tear Resistance. The tearing strength of paper is the force required to tear a specimen under standardized conditions after the tear has been started. It is sometimes called internal tearing strength. Tearing resistance is important in papers that must be durable such as map paper, utility paper, and some types of book paper. In papermaking, a compromise must be made between tearing strength and tensile strength as it is not possible to treat paper to obtain a sheet having simultaneously maximum tensile strength and maximum tearing strength.

g. Folding Endurance. Folding endurance is the number of folds which a paper will withstand before failure. It is a measure of durability and is important for papers used in maps, pamphlets, and manuals.

h. Smoothness. Paper smoothness is essentially the surface flatness when subjected to normal printing pressure and relates to the deviations of the paper surface from an ideal plane surface. It is not the same as gloss, which is an optical property, nor porosity. Because of the compressible nature of paper, the smoothness of a sheet as it lies on a plane surface is not the effective smoothness during ink transfer in printing. Smoothness largely determines ink consumption in printing, the quality of dot formation in halftones, and finish of the printed image. For any given image, the printed reproduction will have better definition and appear darker when applied to smooth, hard-surfaced papers than it will on rough, soft-surfaced papers. The best printing papers are those which are formed evenly and have not been calendered excessively, since excessive calendering causes blackening of the paper and produces hard spots which have poor ink receptivity.

i. Pick Resistance. The surface bonding strength is an important property of printing papers. Poor bonding results in "picking" (a lifting of the surface coating or fibers from the paper as it is printed), resulting in a white spot on the surface where ink should be. The picked fibers may pile on the blanket, contaminate the ink, and eventually show on a subsequent sheet as an ink spot surrounded by a white ring. Paper for offset printing is usually surface-sized with starch to strengthen the surface and prevent picking.

j. Brightness. Brightness is the percentage of white light falling on the paper that is reflected to the eye of the viewer. It contributes to contrast in the printed image and adds brilliance and sparkle to the overall appearance. Brightness should be uniform; variations detract from image quality, particularly in large areas of halftone tints.

k. Curl. Curl can cause misregister and uneven feeding by interfering with the feeder mechanism and register guides. In addition, offset impressions may cause buckling or fanning out if the paper is not free from curl. Fanning occurs at the back edge of the sheet where the paper is not held securely. Curl may be inherent or built in, or it may be caused by changes in the moisture content of the paper; it is greatest during periods of low humidity.

D-2. Types of Printing Papers

This listing of printing papers and their uses includes only those papers in general use. There are many other papers used in the printing industry which are too numerous to be included in this listing.

a. Newsprint. This type of paper is used for low quality printing of catalogs, pamphlets, newsletters, and newspapers. Printed matter may be printed on face or back and may consist of text, line illustrations, and images from halftone screens not exceeding 65-line.

b. Machine-Finish Book. A low bulking paper (average thickness: 0.0022 in.) used for letterpress printing of books, catalogs, periodicals, and pamphlets which are not to be written on with

pen and ink. Printed matter may include text, line illustrations, and images from halftone screens not exceeding 85-line.

c. Offset Book. This paper can be used for multicolor letterpress and offset printing of books, catalogs, pamphlets, folders, and circulars. The 100 pound or heavier types of this paper can be used for solid reverses and heavy halftones. Line illustrations, text, and halftones up to 133-line screen may be printed on this paper.

d. Litho Coated Book. A paper suitable for high quality multicolor face and back offset printing of books, pamphlets, magazines, periodicals, and brochures. Text, line illustrations and halftones up to 150-line screen can be printed on this paper.

e. Mimeograph Paper. This paper is suitable for mimeographing and letterpress printing of circular letters, notices, and forms but is not suitable for quality offset printing because of its low-pick resistance. Text and line illustrations can be printed on this paper.

f. Duplicator Copy. This type of paper is used for duplicating by the liquid (spirit) duplicator process. Circular letters, notices, and office forms can be printed by letterpress on this type paper.

g. Writing. A paper suitable for letterpress and offset printing. Lightweights of this paper generally are used for forms; heavier weights can be used for printing books, pamphlets, catalogs, and open forms. This paper is not suitable for printing which requires high opacity. The best grade of this paper (rag content paper) can be used for letterpress and offset printing of stationery, letterheads, certificates, citations, and diplomas, requiring good pen and ink receptivity, erasing qualities, and permanence.

h. 50 Percent Rag Lithograph-Finish Map. This paper is used for high-quality multicolor offset and letterpress printing of maps, charts, and inserts requiring good folding endurance and semipermanence. Text, line illustrations, and halftones up to 150-line screen can be printed on this paper.

i. High Wet Strength Map. A paper suitable for high-quality multicolor printing of field books, maps, charts, and folded inserts by offset and letterpress. This paper has a very high folding endurance, tear resistance, wet and dry bursting strength, and wet and dry tensile strength. It also contains high wet strength and water-resistant properties, making it particularly suited for use in the field during all types of weather conditions. Text, line illustrations, and halftones can be printed on this paper.

j. Chemical Wood Lithographic-Finish Map. This paper is used for high-quality multicolor offset and letterpress printing of maps, charts, and folded inserts requiring a fairly good folding endurance. Text, line illustrations, and halftones can be printed on this paper.

k. 50 Percent Rag Whie Chart—100 Percent Rag White Chart. This paper is used for high-quality multicolor offset and letterpress printing of maps and charts. It has high folding endurance and permanence.

l. Manifold Paper. A paper suitable for letterpress and offset printing, generally one side only, of forms and correspondence. This paper is lightweight, has low bulk, and is low in opacity.

m. Bond Papers. This paper is used for letterpress and offset printing of stationery, circulars, and forms requiring pen and ink receptivity and good erasing quality.

D–3. Paper Requirements for Offset Printing

a. Offset. Lithography is capable of quality printing on a variety of papers, including bond, machine finish, vellum, parchment, coated, and various paperboards, as well as embossed and special finish papers. Because its impression surface is a resilient rubber blanket that conforms to the surface being printed, offset is the only high-speed process that can print high-quality halftones on both smooth and rough surfaced paper and board. The offset press impression differs from that of the letterpress or gravure printing in that—

(1) The impression is a uniform squeeze over the entire sheet. There are no gutters or routed-out areas where slack can be taken up.

(2) The lithographic plate is a single unit. Individual cuts or pages cannot be shifted to improve register.

(3) Offset printing applies a thinner film of tackier ink, hence the pull of the ink on the printed surface is greater.

(4) The lithographic plate carries moisture on both the printing and nonprinting areas. Part of this moisture is transferred to the offset blanket, and thence to the surface of the paper. It is because of these characteristics that papers for offset printing must have properties superior to those for papers produced only for letterpress or gravure printing.

b. Flatness. Because of the uniform squeeze of the offset impression, paper or board that is not perfectly flat will be distorted in printing. Lack of flatness is due primarily to nonuniform moisture distribution. If a stack of paper is exposed to damp atmosphere, the edges of the sheets absorb moisture, expand, and become wavy. If the atmosphere is very dry, the edges lose moisture and contract, resulting in babby or tight-edged sheets. Either condition can cause wrinkles in printing, but even though there is no wrinkling, either condition will cause serious register trouble in multicolor printing.

c. Grain Direction. The grain direction should be in the long dimension of the sheets (known as "grain-long") since, for any change in moisture content, paper expands or contracts more across the grain than with the grain. In addition, since the pressplate is a single unit, registration cannot be adjusted in a direction parallel to the cylinder axis. For these reasons, it is important to have the direction of greater dimensional change (cross-grain) along the short dimension of the sheets, i.e., around the impression cylinder. Register of images can be easily adjusted in the cross-grain direction by shifting packing sheets from plate to blanket cylinders, or vice versa. In general, grain-short paper should only be used where economy requires it, and then only where a single press run is involved. It should not be used for multicolor printing requiring close register or more than one press run.

d. Pick Resistance. Since offset inks generally are tackier than letterpress inks and are printed in a thinner film, papers and board for offset printing must have greater pick resistance than letterpress papers. Otherwise, surface picking, blistering, splitting, and tearing will occur, particularly in solid printed areas. Such damage is most apt to appear in solids near the back edge of the sheets.

e. Moisture Resistance. Since offset printing brings the paper into close contact with a moist blanket, offset paper must be moisture resistant. For multicolor printing, where the paper contacts the moist blanket two or more times, the paper needs more moisture resistance than for monochrome printing. Insufficient moisture resistance can cause trouble with both uncoated and coated papers. Uncoated papers are mostly surface-sized with starch to reduce their ink absorbency and improve the bonding of surface fibers and mineral filler. But if the fiber bonding is too weak, the press moisture softens the starch so the fibers can be lifted by the pull of the ink. This usually occurs on the second, third, or subsequent press run, when moisture from preceding press runs has had time to soften the starch sizing. As a result, fibers are lifted so that the printing looks and feels rough, and some fibers are transferred to the blanket, plate, and ink rollers. The coating adhesive for coated offset papers is principally a protein material such as casein, soybean protein, or a mixture. It may contain some starch and latex, but should be moisture-resistant enough to permit multicolor printing without the coating transferring to the blankets.

f. Moisture Absorbency. Offset paper and board must be capable of absorbing the water droplets carried on the surface of the ink image. This water must be absorbed into the paper surface before the ink can take hold or trap. Otherwise, these water droplets act as barriers to the ink, preventing complete transfer. As a result, the ink impression, particularly in solid areas, appears gray or weak. Through a glass, it appears full of light spots commonly referred to as snowflakes. Lack of moisture absorbency can be caused by greasy or waxy materials in the paper surface. It is usually more troublesome with coated paper than with uncoated papers.

g. Minimum Curling Tendency. For efficient press operation, paper must be reasonably flat and should not develop any appreciable curl as a result of printing. Both letterpress and offset can cause paper to curl at the back edge (known as tail-end hook) if extensive solid areas are printed close to the back edge. However, offset sometimes causes a peculiar type of curl owing to the moisture applied to the paper by the rubber blanket. This moisture swells the surface fibers, causing the paper to curl in the grain direction and away from the printed side. This curl is only temporary. When the paper dries, there is a reversal of this initial curl, the final curl being toward the printed side. The final curl is permanent and may be either with or against the paper grain. This curl is due to a relaxation of stresses caused by drying and shrinkage of the surface fibers. Moisture curl is negligible for boards and heavier weight papers, but it can be troublesome with papers lighter than 60-pound basis weight.

h. Ink Absorbency. The ink absorbency of paper determines its ability to absorb or repel the ink film. It is primarily a surface characteristic, dependent upon the degree of surface sizing or the

APPENDIX E

OFFSET PRESS DIFFICULTIES

Difficulty	Cause	Remedy
1. Sheets reach front guides out of time	a. Too much or too little friction against sheet. Too much friction can bind sheet and slow it down. Too little friction can permit conveyor tapes to slide under the sheet and fail to carry it.	Check adjustment of two-sheet choke tapes, drop bar, and pull-in wheels. Short sheets may require additional wheels to add friction against tapes.
	b. The feeder pile being too high could cause the suckers to pick up more than one sheet, resulting in a drag of the pile-control post head on the sheet.	Reset pile height.
	c. Incorrect timing of the sucker vacuum cam will release the sheet at the pull-in wheels either too soon or late.	Reset timing of sucker release cam.
	d. Excess pressure of feeder back bars against feeder pile will cause a pause in the sucker pickup action.	Reset feeder back bar
	e. Side pile finger assemblies set too tight against corners of feeder pile will result in fingers resting on top sheet, causing a drag on sheet.	Reset pile finger assembly
	f. Too great airblast causes the sheet to float backwards, resulting in being forwarded out of time.	Reduce airblast
2. Sheets do not separate freely	Poor or insufficient winding, or gum or water spilled on pile during previous press runs. (May also be due to offsetting or sticking.)	Wind stock to separate sheets and get air between them. Throw away sheets that are too badly stuck together to salvage.
3. Stock does not lie flat	Variation in absorbed humidity, or running excessive water on previous press runs.	Condition paper to pressroom humidity. Use wedges and adjust airblast to decrease curl of stock on feeder board. Use metal straps (or improvised) devices to hold curl down on conveyor board.
4. Sheets feed erratically	a. Static electricity. Static is encountered whenever the relative humidity of the pressroom falls below 35 percent. When static is present sheets cling together or to press, interfering with normal feeding and printing.	Use air conditioners to keep humidity above 35 percent. Static difficulties can be reduced by grounding press and stretching metal tinsel across several places along stock path to absorb static charge. Smearing glycerin on suckers and other parts of feeder and delivery assemblies may help. The glycerin will not leave a stain after it has dried.
	b. Variance in size of stock	Check trailing edge of stock pile. If a "saw tooth" effect is present, remove to cutter and trim trailing edge or replace stock.
5. Overall lightness or uneven streaks. Ink on sheet is not of proper density.	a. Too little ink being used	Increase number of notches on ink ratchet, or turn appropriate ink fountain keys out uniformly.
	b. Ink fountain empty, or ink may be backing away from fountain roller.	Fill fountain if necessary. Stir ink (automatic agitators are manufactured that will stir the ink during the run), or add a varnish that will make the ink flow.

Difficulty	Cause	Remedy
	c. Ink fountain keys may be improperly adjusted, causing insufficient flow or uneven distribution of ink.	Ink fountain keys should first be set to distribute ink uniformly, and then adjusted during makeready to plate requirements. A thin film of ink (adjusted by keys), and a long revolution of the fountain roller (adjusted by ratchet assembly) is preferable to a heavy film of ink and a short revolution of the fountain roller.
	d. Ink distributing rollers may be improperly adjusted, preventing ink from reaching the form rollers. (This is easily recognizable because some of the ink rollers will be carrying a visibly light or insufficient film of ink, especially when first inking the press.)	Distributing rollers must be properly seated and adjusted to maintain proper contact with fountain, vibrators, and form rollers.
	e. Ink form rollers may be improperly adjusted, failing to receive ink and/or deliver it to the plate. (This is recognizable because the image on the plate does not receive ink, and will not transfer ink to an applied fingertip.)	Form rollers must contact vibrators and plate with proper pressure. Inked form rollers dropped against a stationary gummed plate should leave strips of equal width at both ends and (depending on the size of the press) from ⅛ to 5/16 inch wide. Form rollers must remain in contact with vibrators when passing over plate cylinder gap.
	f. Blanket and/or plate may be underpacked, causing the plate to fail to receive ink and/or causing the image to fail to transfer from the plate to the blanket. (This can be easily detected by examining the blanket to see if the amount of ink on the blanket is proportional to the amount of ink on the plate.)	Blanket and plate should be packed sufficiently above bearer height to achieve .003 or .004 inch printing pressure.
	g. Impression cylinder pressure too light for sheet to receive image from blanket.	Increase impression cylinder pressure.
6. Ink may be of proper density on sheet, but will appear "gray," dull, and lifeless.	Too much water being used ----------	Reduce water to minimum required for printing without ink catching up.
7. Weak areas in otherwise acceptable print.	a. Blanket surface may be dented or depressed, preventing transfer of image from plate to blanket. If the plate is good, the image will print properly where the blanket is undamaged, but will not appear on the blanket in the dented areas.	If blanket impressions are not severe, apply commercial blanket swelling preparations to the underside of the blanket. If depressions are severe or deep, underside of blanket under the depressed area should be built up with layers of tissue paper.
	b. Low spots in cylinder surface ----------	To patch low spots in the blanket cylinder surface, strip plate and blanket cylinders bare, and cement a good new blanket to the plate cylinder with underpacking to total the usual dimensions of both cylinders. Then ink the blanket (on the plate cylinder) up solid, pull the impression cylinder away, put the impression on, and turn the press around to ink up all of the blanket cylinder surface. Paint the portions of the cylinder surface where ink does not transfer with lacquer. When the lacquer dries, repeat the operation, adding lacquer where needed until the entire surface of the cylinder receives an even ink transfer. The patches will be permanent if carefully trated.

nature of the coatings. Paper for offset printing must have uniform ink absorbency—

(1) Over the paper surface,

(2) From sheet to sheet in a lot of paper,

(3) From lot to lot of paper of the same manufacture and finish.

i. Ink Drying. Temperature, relative humidity, press moisture, and acidity of press moisture all affect the rate at which ink dries on paper. Paper can also affect ink drying. For uncoated papers, the main retarder is acidity. This can be measured in terms of pH. Papers having pH values between 4.5 and 6.0 rarely give trouble but below 4.5 serious trouble can result, especially in humid weather. For coated papers, the acidity of the coating determines how fast the ink will dry. Most coatings are alkaline; the more alkaline the coating, the faster the ink will dry.

D–4. Paper Storage and Conditioning

a. Temperature. When paper is received, it should be in exactly the same condition as when it left the mill except for its temperature. In winter, it may be colder, and in summer, warmer, depending on outdoor weather conditions. If its wrappings are intact, it will be unchanged in moisture content and just as flat as when originally packed for shipment. Skids of paper should be checked for tears or breaks in the protective wrapping. Any damage to the wrapping should be repaired immediately with gummed tape to prevent air from reaching the paper. Paper should then remain unopened until its temperature is in balance with the temperature of the pressroom. During the winter months, the paper may be quite cold when received. If it is unwrapped immediately in a warm area, it will quickly become wavy-edged from moisture condensing on the paper edges. This condensation is due to an increased relative humidity created as the cold paper cools the surrounding air. Paper that has developed wavy edges is permanently damaged and cannot be returned to its original flat condition by any practical method. During the summer months, paper may be warmer than the pressroom when received. If unwrapped immediately, it will warm and reduce the relative humidity of the surrounding air, causing the edges of the paper to lose moisture and shrink. Avoiding these effects is more practical than correcting them. Wrapped paper should be stored for a few days at pressroom temperature before removing the wrapping. Storage must be in the pressroom, or in a storage area at the same temperature, and preferably at the same relative humidity as the pressroom. Paper should never be stored in unheated areas in winter. The time required for paper temperature to become balanced with pressroom temperature is largely determined by the difference in temperature and the cubic volume of the paper. The temperature of paper can be determined by cutting a small slit in the wrapping and inserting a thermometer so that the bulb touches the paper. Read the temperature after it becomes constant, and seal the wrapping with tape. Refer to table D–1 to find the time necessary to bring the paper into temperature balance. However, if paper is stored at pressroom temperature for a week or more before use, even the largest stacks will become adjusted.

b. Moisture. Once the paper has been brought to the pressroom temperature, it should be tested for moisture balance. The moisture content of the paper should equal or be nearly equal to the pressroom atmosphere. The relative humidity of the paper can be determined by using a sword hygrometer or a paper hygroscope. Before using either of these instruments, they should be waved back and forth until the pointer no longer moves. The blade of the instrument should then be inserted into the stack of paper at a point not less than 6 inches from the top, and the movement of the pointer from zero noted after 1 minute. To accomplish good register, the paper should have a relative humidty (RH) about 5 percent more moist than that of the pressroom; however, readings of 2 percent drier to 8 percent moister should keep the paper flat and free from wavy or tight edges. Testing paper for moisture balance should be done immediately after unwrapping. If it is in satisfactory balance, it can go to the press immediately. If not in satisfactory balance, the paper should be hung and conditioned immediately. The purpose of moisture conditioning is to bring the paper's moisture content uniformly to balance with the pressroom atmosphere so it will not expand or shrink or develop wavy or tight edges. To condition paper, the sheets must be exposed to the air individually. This is best done by hanging the paper in small lifts for a period of 24 to 48 hours or until the paper comes into moisture balance. The sheets should be hung from one edge for half the conditioning time, then reversed and hung from the opposite edge. Sheets should be hung with the grain direction vertical since lightweight papers, especially coated papers, sometimes develop a sag if hung with the grain horizontal. The

conditioning time depends on the type of paper and the amount of effective air circulation. Dense, heavyweight papers will take longer than porous and lightweight papers. The amount of air contacting the sheets is most important as air is the medium by which moisture is added to, or taken from the paper. The rate of moisture transfer depends on the difference in relative humidity between the air and the paper. Since this difference decreases continually during conditioning, the rate of moisture transfer becomes slower. Complete moisture balance is never reached but in a reasonable time it becomes close enough for practical purposes. Whether or not the paper needs to be moisture conditioned before use depends not only on its moisture balance, but also on the nature of the job to be printed, the size of the press sheets, and the number of press runs. If the paper cannot be printed or conditioned immediately, it should be rewrapped until it can be used. In pressrooms which are not airconditioned, stacks of conditioned paper should be protected by moisture-proof covers between press runs. Covers made of plastic, polyethylene, or plastic impregnated material are best but must be large enough to extend from the top of the stack to the skid. Covers should be sealed to the skid with tape. In air-conditioned pressrooms, where the temperature and relative humidity are constant, paper stacks need not be covered between press runs.

Table D–1. Temperature Conditioning Chart for Paper

Time paper should stand, unopened, in order to come into balance with room temperature

Cubic volume of paper (cubic feet)	Temperature difference between paper and temperature of pressroom (room in which paper is to be printed)							
	10°	15°	20°	25°	30°	40°	50°	60°
	Hours	Hours	Hours	Hours	Hours	Hours	Hours	Hours
6	5	9	12	15	18	25	35	54
12	8	14	18	22	27	38	51	78
24	11	16	23	28	35	48	67	100
48	14	19	26	32	38	54	75	109
96	15	20	27	34	41	57	79	115

Note. Determine cubic volume of paper by multiplying length x width x height in inches and dividing by 1,728.

8. Weak, mottled print	a. Blanket may be glazed, owing to poor cleaning. The glaze is an accumulation of oxidized rubber, varnishes, and gum.	Wash blanket thoroughly with an ink solvent and water. If glaze remains, scrub well with the ink solvent and pumice powder.
	b. Blanket may be dirty or oily	Use same procedure as in item 8a.
	c. Impression cylinder may have insufficient pressure against blanket cylinder, preventing the image from transferring between the blanket and the stock.	If the image appears satisfactory on the blanket, increase the impression cylinder pressure until an even print is obtained. When the cylinders are out of parallel, or not equipped for parallel movement, consult press manual for procedure and adjust for thickness of stock.
	d. Blanket may be insufficiently packed for impression cylinder, i.e., when printing on thin stock, the impression cylinder of certain makes of presses cannot be moved sufficiently close to the blanket cylinder for proper printing contact.	Increase blanket cylinder underpacking, and remove equal packing from under plate to maintain proper printing pressure. **CAUTION** This may cause change in image size, affecting register in multicolor work.
9. Weak print, becoming progressively weaker going across cylinder.	Cylinder bearing may be worn and/or cylinders may be out of parallel, causing insufficient or uneven transfer between plate, blanket, and stock. The image will not transfer properly between the affected cylinders.	Paralleling of cylinders and/or replacement of bearings may be necessary.
10. Weak, gray or spotty print	a. Steel ink rollers may be stripping. Steel rollers fail to carry ink. Noticeable as strips of bare metal around roller circumference. Caused by glazed rubber rollers, running too much water, or too much acid in the fountain solution.	If due to glazed rubber rollers, correct cause. Otherwise, wash up rollers in regular manner, then wash up with a weak nitric, acetic, or hydrochloric acid solution, scrubbing with pumice powder if condition is severe. Then wash roller with plain water. Weekly procedure to prevent stripping: Wash up press in usual manner, make a paste of pumice powder and oleic acid, add it to the rollers, and run the press for several minutes. Then wash up again.
	b. Rubber ink roller may be glazed. Usually due to ink and drier remaining in the pores of the rubber due to improper washup. This causes the rubber to lose its ink-carrying and distributing qualities.	Thoroughly scrub roller with an ink solvent and pumice powder to remove the glaze and restore the proper velvety sheen. Washing up with a 3 percent lye solution may also help. If glaze is extensive, roller should be buffed with sandpaper, ground down, or recovered.
	c. Ink too stiff to adhere to image. Appears as weak spots in image on plate, blanket, or stock. The ink's affinity for itself is greater than its attraction to the plate.	Add a thin varnish to the ink
	d. Ink may be emulsified or waterlogged. May be caused by use of too much drier, too much water, too alkaline a fountain solution, a gum left on a poorly washed-off plate, or poor ink. (Very fresh ink, which has not been "aged" for a long enough period, is very susceptible to emulsification.)	Correct causes. If condition is severe, replace ink.
	e. Ink becomes waterlogged because of small image area, which does not use ink fast enough.	On forms where the ink coverage is not great, and there is some waste paper (preferably at the back edge of the sheet), it is helpful to put in a small solid area; a strip ¼ inch wide running across the plate would be sufficient. This insures a sufficient replacement of the ink on the rollers.

Difficulty	Cause	Remedy
11. Blank areas in image	Ink form rollers may be cracked or pitted, as a result of careless washup over a long period.	None, except to replace rollers. Correct cause.
12. Uneven print	a. When cylinder diameters are unequal, the blanket creeps, and smooth packing sheets will wrinkle and cause an uneven print. The coarser the canvas backing of the blanket, the greater the extent of wrinkled packing.	It is good practice to place the thin packing tissues close to the steel cylinder, and the heavier sheets close to the blanket. Applying a thin coat of machine oil to the tissues with a cloth and wiping it off will help to prevent the steel from rusting.
	b. Rough textured packing (like regular offset paper) retards wrinkling, since it moves with the blanket. With each revolution of the cylinder, the packing comes back to its original size, providing the steel cylinder surface is smooth.	Using soapstone or talc between the blanket and the top packing sheet reduces the friction of canvas against packing. This more evenly distributes the strain placed on the blanket when tightening the reel, and permits a more uniform overall print.
13. Mottled print	a. Ink may be too stiff or too tacky, causing fibers to be plucked or picked from the stock.	Thin or soften the ink with varnish, mixing thoroughly and adding no more than is needed to correct condition. Keep a record of proportion added for future reference. Use of excessive water is also a contributing factor to picking, so a minimum of water should be run.
	b. Ink may contain lint, owing to picking of stock, dirty stock, or old, fuzzy dampening rollers. Any of these conditions can cause lint to become mixed with the ink, resulting in a mottled print.	Correct causes. See item 29 for procedure to correct picking. If necessary, wash up and replace ink.
14. Ink density too heavy on printed sheet. Ink spreads to background areas. Print lacks sharpness.	a. Too much ink being used	Reduce number of notches on ink ratchet, or turn appropriate ink fountain keys in. It may be necessary to remove excessive ink from the rollers by sheeting.
	b. Ink too soft or too greasy	Do not add thin varnishes to ink unless necessary to prevent plucking of stock. Stiffen ink by working in a quantity of No. 8 varnish or magnesia powder.
	c. Too little water being used	Increase water supply at fountain to minimum required to print properly.
	d. Ink piled up on form rollers, owing to ink vehicle not being able to carry pigment. Drier may have been added too soon, causing setting on rollers.	Add a heavy varnish. Add driers at the last possible moment before using ink on press. If this does not remove the scum, obtain new plate.
	e. Fountain solution reacts with paste (lead) drier in ink, forming a glassy film on the plate and causing difficulty in controlling water distribution.	Reduce amounts of acid in fountain solution and of drier in ink. If necessary, replace ink.
	f. Paper stock unsuited for offset printing. Some coated stocks may pick off readily, and may contain a large percentage of alum or other chemicals. These chemicals sensitize the plate to grease, causing scum.	If such stock must be used, "doctoring" of ink to soften it, frequent washups, and a more acid fountain solution will be necessary.
15. Overall tint, usually of less than full color density. Tint does not wash off plate with water. Possible appearance of faint streaks across cylinder.	a. Dampener form rollers set too tight against plate, causing wear of the plate grain either from excessive pressure or from the "bounce" which is likely to develop.	Readjust rollers. Rollers should be checked for warping and/or uneven diameters. If excessive plate wear has not occurred, plate etching the scummed areas may bring relief. Otherwise, a new plate will be required.
	b. Blanket and plate cylinders packed to excessively unequal diameters. This prevents true rolling contact	Repack cylinders to equal diameters. Etch affected areas of plate.

	and causes skidding between the two cylinders, wearing away the plate grain.	
6. Ink appearing in background areas in specks or blotches of full color density.	a. Running too little water	Increase water to minimum required to prevent plate from catching up. Proper balance between ink and water must be maintained so that a full density of ink, without scum, is transferred to the stock.
	b. Dirty dampening rollers not carrying or transferring water. Caused by running too much or too greasy ink, or insufficient acid in the fountain solution.	Scrub fabric rollers with a stiff brush and water, using soap or solvent only if absolutely necessary. Rinse rollers thoroughly and hang up to dry. If condition is too severe to permit cleaning, replace fabric roller covers. Clean metal rollers with an ink solvent to remove grease and ink, then rinse with water. Then scrub roller with pumice powder and plate etch, wash with water, and gum.
	c. Low or high areas in dampening rollers preventing even contact with the plate.	Manually scrape, rub up, or underlay with strips of muslin, the low areas. Place rubber water stops against the water fountain roller in wetter areas.
	d. Dampening form rollers too long for press, riding the bearers, and not contacting the plate properly.	Procure proper length rollers for press.
7. Overall tint, usually of less than full color density. Tint does not wash off plate with water.	a. Greasy or poor ink	Etch plate. Increase acidity of fountain solution. Mix powdered magnesia into ink to stiffen it, or replace with good ink. Do not reduce ink with greasy compounds unless necessary to prevent plucking.
	b. Insufficient acid in the fountain solution to overcome greasiness of ink.	Fountain solution should not be higher than 4.6. If this pH does not overcome difficulty, new plate should be made.
	c. Oxidized plate. May occur in graining, platemaking, storage, or on press because of exposure to dampness or slow drying of water on plate. When a plate oxidizes, the spots of ink on the background are solid and perfectly round, regardless of size. This should not be confused with spots of pigment from bleeding ink.	See item d below for procedure of eliminating local oxidized areas. Badly oxidized plates are usually regrained or discarded.
	d. Plate defective. Becomes evident at start of run as general or localized scumming, owing to incomplete development, too thin a coating, overdevelopment, a poor negative, or overgreasy developing ink.	Attempt to clean plate with plate etch, alternately sponging with etch and water. To remove local tint scum, use pumice powder or snakeslip, follow with plate etch, and then wash with water.
	e. Fountain solution too acid, causing eating away of the plate grain, and/or of the thin protective gum film on the plate surface.	Reduce acidity of fountain solution.
8. Discoloration of water on plate and printed sheet. Tint can be easily washed off with water.	a. Ink bleeds, due to coloring matter not being fast in water.	Reduce acidity and amount of fountain solution. It usually will be necessary also to replace the ink.
	b. Ink emulsified—mixture of pigments, varnishes, driers, etc., breaks down. Results from emulsifying action of wetting agents. (Gum arabic is a weak wetting agent.) May also be due to ink being too fresh—ink	Strengthen ink with long varnish. Cut down amount of wetting agents. If condition is severe, replace ink.

Difficulty	Cause	Remedy
	should age at least a week after grinding to permit thorough combining of all ingredients.	
19. Ink filling in open areas or image thickening.	a. Too much ink used at start of make-ready. Rollers cannot lift the ink cleanly from the plate in such cases, causing the work to thicken and scum.	Correct cause. Attempt to clean plate by etching.
	b. Excessive ink	Decrease ink supply.
	c. Greasy ink	Stiffen ink with No. 8 varnish or magnesia powder, or replace ink.
20. Ink filling in open areas or image thickening. Slight blur apparent toward tail end of sheet.	a. Loose blanket	Tighten blanket
	b. Loose plate	Tighten plate
	c. Excess pressure	Check cylinder contacting pressure
	d. Loose roller settings	Reset rollers
21. Blurred areas at regular intervals from front to back of sheet.	Blanket too loose. Humps rise in the rubber, and then slip across the plate.	Tighten blanket
22. Tails on dots, or slight blur at back of image, especially at tail end of sheet.	a. Blanket slightly loose. Hump appears only at end of cylinder revolution.	Tighten blanket
	b. Excessive pressure between cylinders.	Repack cylinders, or adjust impression cylinder pressure as necessary.
	c. Blanket rubber swollen due to absorption of varnishes, driers, and solvents.	Clean blanket thoroughly, or replace with good blanket
23. Streaks of ink running completely around cylinder, of same width and shape on every sheet.	a. Damaged form rollers. (Usually caused by some device on plate cylinder protruding beyond plate height.)	If rollers are not too badly damaged, treat as in item 16c. Otherwise, replace rollers. Check for offending device on plate cylinder, and tighten if necessary.
	b. Dirty wheels, tapes, or control devices in the feeder, conveyor, or delivery assemblies. (May have picked up ink from previously printed colors.)	Clean all devices which contact sheets and, if possible, shift them to an unprinted portion of the sheet.
24. Streaks of lightness in image running around the cylinder. These streaks will vary somewhat in size and shape, and usually will become progressively smaller in area with each succeeding sheet.	Too much water	Decrease water supply. Also check for possible emulsification of ink. (See item 10d and correct if necessary.)
25. Scum, alternately light and dark, taking the forms of streaks across cylinder. (Commonly called "gear" streaks), or similar light and dark areas in image. Appears especially at gripper edge of sheet.	a. Squeeze pressure, instead of bearers, driving cylinders. This prevents the bearers from smoothing out the slight chattering action of the gears.	Decrease cylinder packing
	b. Excessive difference in cylinder diameters due to incorrect underpacking. Humps rise in blanket and slip across the plate, squeegeeing away enough water to allow a slight scum.	Repack cylinders properly. Cylinder diameters should be as equal as possible.
	c. Difference in surface speeds of driving roller and plate cylinder, causing form roller to drag against driving roller or plate.	If plate cylinder is packed properly, and rollers are set with proper pressures, their relative surface speeds should be correct.

	d. Ink form roller sockets worn. Rollers bounce into cylinder gap, lose speed, and then skid when they again contact the plate.	Reset rollers to proper tension. If necessary, replace roller sockets.
	e. Ink or dampener form rollers set too tight or too loose to their respective vibrators, causing them to skid on the plate.	Reset rollers to proper tension
	f. Glazed ink form rollers skidding on vibrators or plate.	Clean or replace affected rollers
	g. Rubber form rollers swollen, causing skidding against vibrators or plate.	Clean or replace, and rest affected rollers
	h. Improper press timing. Rollers should vibrate at time plate cylinder gap is up. If the vibrating occurs at any other time, the slight hesitation is apt to cause skidding of the form rollers.	Retime vibrator motion
	i. Gear teeth on cylinders or vibrators worn or dirty ----	Clean affected gears
	j Play between plate and blanket cylinders ----------	Adjust gear segment. See press manual for procedure.
	k. Cylinder bearing trouble. Since all three press cylinders are geared together, binding of the bearings of any one will affect the others and interfere with steady even contact between the plate and form rollers.	Depending on the nature of the difficulty, oil press, level press, or install new bearings.
	l. Kinks or humps in plate or cylinder underpacking, causing skidding of the form rollers.	Flatten kinks, repack plate, or replace plate
	m. Poor paper. Certain kinds of paper (especially very hard coated) show "gear" type streaks regardless of adjustments to press or ink.	Some regular offset stock should be run. If streaks do not then appear, it is the fault of the original stock. The streaks can be eliminated only by replacing stock.
	n. Greasy ink or excessively soft ink accentuates any minor irregularities (see above) that might otherwise go unnoticed.	Correct causes, or stiffen or replace ink
. Weak, gray, or spotty appearance of image on printed sheet.	a. Fountain solution too acid or too alkaline. Too much acid dissolves grain of plate and undermines image. Too alkaline a solution causes image to soften and dissolve.	Take a pH reading of solution. Add acid or water as needed to attain desired pH for type of plate being run (usually 4.6 for aluminum). In extreme cases, replacing solution and/or rollers may be necessary. Rub ink and/or asphaltum into weak areas Small areas or lines can be made to print by scratching them with pencil or etching needle. Otherwise, replace plate.
	b. Etch used carelessly, or too strong. If the etch penetrates the ink film on the image, it is almost certain to destroy the grease-receptiveness of the image.	Do not etch plate, unless image is protected with ink or asphaltum by lacquer. Do not allow etch to remain on image areas over 1 minute.
	c. Gum used carelessly, or gum sour ----------	Use gum carefully, as it, too, is a weak desensitizing agent. If gum is sour, replace with fresh gum.
	d. Too much fountain solution and/or not enough ink used. Water gets ahead of ink on the printed sheet.	Unless quickly remedied, the water will penetrate and undermine the image. Wash plate with clean water, and gum carefully. Wash out image with turpentine. Rub a quantity of ink into the image with cheesecloth and smooth it down dry. Wash gum off plate and bring water rollers against plate. If the plate is basically

Difficulty	Cause	Remedy
		right, it will again be clean and sharp if the proper water-ink balance is maintained.
	e. Developing ink or press ink on image has dried hard, losing its grease-receptiveness. Although this is not truly a blind plate, it is often mistaken for one.	Wash dried ink off with turpentine. Plates which are to be stored for any length of time should be asphaltumed to prevent this occurrence. A greasy asphaltum can be made by adding 1 ounce of oleic acid to 1 gallon of asphaltum. This will insure the image taking ink when the plate is used after storage.
	f. Normal life of plate exceeded	Replace plate. On runs that approach maximum plate life, extra plate should be available to assure minimum loss of time.
	g. Cylinders out of alinement, causing excessive wear	Realine cylinders
	h. Poor plate. A plate that is underexposed, has too thick a sensitized coating, or has an insecure foundation owing to gum remaining on the grain before sensitization, disintegrates rapidly on the press.	Obtain a new plate
	i. Gum streaks or spots. Spots in image on the plate. Gum may not have been applied smoothly or rubbed down evenly in platemaking or on the press. Usually more pronounced if gum has soured. Results in image areas being sensitized.	Use same procedure as for a blind plate. See item 26a. Rub the affected image area, first with a sponge containing both water and gum arabic, and then with a firm cloth pad containing rub-up ink and pumice powder. Then alternate until image becomes ink receptive. The water dissolves existing dry gum and the added gum is to replace dissolved gum of the nonimage areas. The pumice powder is used as an abrasive, and the rub-up ink to make the blind image grease receptive.
	j. Binding due to lint or dust. The presence of lint or dust picked from paper stock can cause halftone images to sharpen.	If due to picking, soften ink. If due to dust in stock, little can be done except to adjust the cylinder brush (if press is so equipped) and clean the blanket so that a minimum of dust will be picked up.
27. Ink does not print smoothly on sheet	a. Last color dried too hard to allow next color to gain a foothold.	In multicolor work, the use of cobalt drier should be avoided, especially on the first colors down. Trapping compounds can be procured which will aid in printing on surfaces which have poor attraction for ink. In jobs where colors overprint, it may be necessary to put some retarder in the ink so that the first color down will not dry before the succeeding colors are applied. The ink on all colors should be run as spare as possible.
	b. Under color is waxy or greasy	Keep reducing to a minimum in multicolor work
	c. Piling. Ink cannot distribute or flow properly, owing to excessive drier, poor vehicle, or heavy pigment.	Add long varnish to ink
	d. Hard-surface stock	Use trapping compounds
28. Mottled print, very similar in appearance to product of semiblind image, low blan-	Ink too stiff. Ink of high cohesiveness and/or low viscosity will tend to adhere to itself and to the	Do not confuse with other difficulties listed in Difficulty column which have a similar appearance.

ket, or insufficient impression cylinder pressure.	rollers, and will not transfer properly from rollers to plate, plate to blanket, or blanket to stock.	To remedy, thin ink with No. 00 varnish
29. Stock fibers, or bits of stock coating, picked from stock surface.	a. Ink too tacky. Inks are usually made fairly stiff, so that they will not be too greasy on strong-surfaced paper.	Use a hard blanket, minimum back cylinder pressure, and reduce tack of ink. To reduce ink tack, use beeswax or No. 00 varnish.
	b. Low humidity resulting in static electricity.	Relative humidity around press should be at least 60 percent to prevent plucking. See item 40c for ways of raising pressroom humidity.
	c. Caused by the sharp bend in the stock, as it peels off the tacky blanket.	Soften the ink with a commercial nonoffset compound. Use a hard blanket and a minimum of back cylinder pressure. Clean blanket surface to reduce tack.
	d. Lint from trimmings laying between sheets	Reset cylinder brush assembly
30. Paper sticks to blanket	Blanket tacky or dirty	Clean blanket thoroughly, and powder with a half-and-half mixture of talcum powder and flowers of sulfur. Or install new blanket.
31. Stock wrinkles under pressure. Usually associated with thin stocks.	Usually due to poor condition of stock May be aggravated by poor guide or gripper adjustments.	Check settings of guides, undertongues, and grippers. Cut across-the-cylinder notches in the blanket packing to help relieve the offending pressure. Prerun paper conditioning usually eliminates this wrinkling deficiency.
32. Old work shows through as ghost image	a. Plate may be insufficiently grained to remove old work.	Use snakeslip and plate etch to remove old work from plate. If condition is too severe, replace plate.
	b. Blanket embossed, owing to poor cleaning	Replace with new blanket and hang old one up to dry after reconditioning. Every press should have an extra set of blanket bars so that blankets can be periodically rested. This prevents embossing and greatly increases the life of the blanket.
33. Pinholes at same place on each sheet	Due to improper manufacture of rubber blanket, causing pits in the rubber skim coat.	Replace blanket.
34. Checked appearance at edges	Cracked form rollers, due to improper washup. Occurs especially at ends of rollers.	Replace affected rollers. Rollers must receive regular thorough cleaning to prevent cracking and pitting.
35. Excessive wastage	Improper procedure	Wastage in makeready can be greatly decreased in the following way: In the preliminary operations of checking color and position, manipulate the feeder so as to feed and print only one sheet at a time.
36. Image has incorrect, although parallel, margins on printed sheet.	Imperface or incomplete makeready	Swing plate, adjust front guides (for small movement only) and/or move side guide as required.
37. Image not parallel on printed sheet	Imperfect or incomplete makeready	Twist plate or parallel front guides. Since even the best of platemakers make mistakes, the pressman will find it a great timesaver, in the long run, if he checks each plate before mounting to see if the image is centered and parallel to the gripper edge. If the image is correct, the loss of time is negligible; but if the image is crooked, he

Difficulty	Cause	Remedy
		can mount the plate crooked to compensate for the error, and save a good deal of makeready time.
38. Register varies during run. Image does not print in the same place on every sheet.	Imperfect or incomplete adjustment, usually of feeder assembly.	Check the following press components or adjustments: pile too high; feeder back bar and rear pile finger binding the corners of the feeding sheet; airblast so great that it floats the sheet backwards; Wale floating nozzle laying heavily on edge of sheet; two-sheet choke binding one sheet; trolley wheels set too tight or with varying tension; register brushes and wheels permit sheet to bounce backwards at headstops; tension of individual conveyor tapes varies; trip lever binding on the feeding sheet; headstops pinching gripper edge of sheet; setting of headstops too great, permitting sheets to buckle; register drop bar pressure too great, causing a drag on the side guiding; or the sheet slips in the bite of the impression cylinder grippers. Never change press speeds once a multicolor map has started.
39. Image long or short on printed sheet in direction of press rotation (around cylinder only).	a. Stretch or shrinkage of negative b. Paper stretch or shrinkage on previous press runs c. Incorrect underpacking of plate and/or blanket d. Incorrect underpacking of plate and/or blanket resulting from image size changes from previous run and also possible blanket swelling due to chemicals used.	Correction can be obtained (in direction of press rotation only) by increasing packing under plate and removing packing of equal thickness from beneath blanket to shorten image. (Reverse procedure if a longer image is desired.) Each .001 inch of packing changed will cause a change in the size of the image of from .008 to .012 inch. This may lead to other press difficulties, so a choice must be made between degree of register desired as against amount of plate wear and slur that can be tolerated. If error is large, a new negative and/or plate may be necessary.
40. Image prints large or small in both directions.	a. Incorrect camera setting when making negative b. Stretch or shrinkage of film negative c. Humidity change in paper since previous press run	See item 39 for procedure of correcting size of image around cylinder. Remake plate from shrunken or stretched negative Maintaining constant humidity in paper is only effective prevention. Paper is in best condition for multicolor printing if its relative humidity is 5 to 8 percent higher than that of the pressroom air. Some correction is obtained (time permitting) by hanging paper, separating into small piles, or running through the press with or without dampeners against a blank plate depending on whether moisture is to be added or subtracted from the stock. Also, attempt to condition pressroom to agree with humidity at time of previous run. Hang wet rags in front of a fan, or boil water in vicinity of press to increase humidity.

Local misregister at corners of sheet	Paper fanned out due to varying humidity around pile, use of excessive fountain solution or excessive back cylinder pressure during printing.	Condition paper. Stretching of plate at corners or local change of blanket underpacking may be attempted only as a last resort. Make as many corrections as possible before printing another sheet after checking the first one. When checking color and position under close tolerance, make up sandwiches or "books" of waste sheets, with only one good sheet in the center of each "book."
Failure to dry	a. High humidity. Drying is slower at a high humidity	Use more drier, or allow more time
	b. Too much waxy or greasy reducing compound used in ink.	Stiffen ink with magnesia powder, or replace ink
	c. Stock surface too acid, owing to running a strong fountain solution on previous press runs, or chemical reactions between ink and drier on previous runs.	Use more drier and a weaker fountain solution
	d. Moisture content of stock is too high. Moisture retards drying.	Condition stock
	e. Too much or too acid a fountain solution is used. Moisture and acidity retard drying.	Correct cause
	f. Drier has reacted chemically with extender (alumina hydrate), rendering drier inactive.	Do not add drier to ink until just before using
	g. Stock unsuitable. Certain hard surfaced stocks will not trap or absorb the ink properly.	Replace stock. Add commercial trapping compounds
	h. Ink not suitable for paper	Use care in mixing
	i. Drier not thoroughly mixed	Use care in mixing
	j. Wrong drier used. On hard-surfaced paper where little absorption takes place, cobalt drier may form a surface skin which will prevent the ink underneath from drying.	Correct cause
	k. Too much drier used. Some paste driers, if an excess is used, soften the ink just like any other greasy compound.	Hang sheets or blow air through them. Or rerun through press with a drier spray, or overprint with a size that will provide additional nongreasy drier.
	l. Temperature too low. The time needed for chemical reactions doubles with every 20° drop in temperature.	Drying will occur in time. Faster drying can be obtained by winding stock.
	m. Insufficient drier	Increase amount of drier
Failure of ink to dry in center of sheets although dry at edges.	Lack of oxygen	Wind stock
"Spotty" drying	a. Stock is damp in spots. Usually associated with cardboard.	Condition stock
	b. Ink film of previously printed colors is more absorptive than blank sheet. Occurs only if drier is insufficient except where absorption is great.	Hang or wind stock if greater speed is desired. Otherwise, the ink will dry eventually.
	c. Porosity of stock varies, owing to manufacturer's practice of taking the sheets from several different reels when making up reams.	Mix ink to dry on least receptive sheet
Chalking. Vehicle soaks into stock, leaving pigment unbound to the surface.	Insufficient drier, high humidity, or excessive acid in the fountain solution. Setting time of ink is too	Chalking is usually noticed too late to correct the cause. However, the job can be saved by overprinting with a

Difficulty	Cause	Remedy
	short. If the vehicle is absorbed faster than the ink dries, there will not be enough binder left to hold the pigment, and chalking will result.	transparent size (aluminia hydrate or overprint varnish —with drier), using the same press plate that was used to print the affected color. If two or more colors chalk, print size over the entire sheet, using a blank plate and without dampeners. Paper brightness will be slightly lowered, but usually not enough to harm the job. On similar future jobs, add drier and binding varnish.
46. Ink lightens in color during drying	On absorbent book paper or coated stocks, the ink is apt to lighten in color owing to absorption in drying. The harder the paper surface, the thinner the ink film need be. Normally, coated stock requires only ⅔ tp ¾ as much ink as uncoated stock. The softer the paper, the more vehicle it will absorb.	None. On future jobs of a similar nature, run a heavier film of ink, or mix ink tinctorially stronger.
47. Dead, lifeless appearance of ink on printed sheet.	Contrast between some types of stock and ordinary offset ink. Also, the water used in the lithographic process tends to soften the effect of a printed ink.	Use a gloss ink, and print with a minimum of water
48. Discoloration during drying	Cobalt drier is not compatible with certain ink pigments.	See inkmaker for advice
49. "Burning Out" or loss of color during drying.	Due to lack of oxygen. Solids or heavy halftones are most affected. Iron blue or chrome green inks are the usual offenders. Especially likely if a heavy ink film is run or if excessive water was used.	Wind stock as necessary during drying to supply oxygen to all sheets in pile.
50. "Scuffing." Ink dries, but still rubs, smudges, or scuffs easily.	Caused by ink containing too much of nondrying compounds. Such materials soften the dried ink film so that it will not stand rubbing, i.e., the varnish in the ink has dried, but the dried film is diluted with grease and remains somewhat soft. For ordinary work, more than 1 ounce of nondrying material per pound of ink will cause trouble.	Boxes, labels, and similar material should be printed in scuffproof ink. Even then, waxing or varnishing the printed sheets may be necessary.
51. Fading of colors within a few weeks or months after printing.	"Permanency" is only a relative term when applied to inks. Even the most colorfast inks retain their brilliance for only about 6 months when directly exposed to heat, light, etc.	None
52. Offsetting or sticking together of the sheets in the printed pile.	a. Running excessive ink	Reduce ink supply at fountain. Coated or hardfinished stock requires more drier, preferably cobalt, for single-color work.
	b. Failure of ink to dry or set	Add a varnish, compound, or drier to speed the setting time.
	c. Use of excessive drier in ink	When running a hard-surfaced paper or a paper coated both sides, it is wise to use drier judiciously. Driers

		create heat in the printed pile, and both sticking and offsetting may result.
		Application of radiant heat, slipsheeting, or use of a spray gum may be necessary. When running such stock, the ink should be as tinctorially strong as possible to permit running it spare. When starting a long run, remove stock in small lifts until sure that there is no offsetting due to weight of stock.
	d. Static in stock	See item 4 for means of relieving static.

APPENDIX F
MAP SUPPLY AND MAP DISTRIBUTION

F-1. Basic Principles

An efficient supply system is one which insures that appropriate material is gotten to the right place at the proper time, in sufficient quantities, and in good condition. To this end, the Military Standard Requisitioning and Issue Procedure (MILSTRIP) has been established. AR 117-5 directs that maps and related publications be carried as standard stock items, under MILSTRIP. Maps have certain characteristics, however, that make it necessary to modify conventional supply techniques for their distribution. Among these factors are:

a. A map is unique in that it represents a specific portion of the earth's surface, and has military value only with relationship to that portion. It is useless for any other area.

b. Because of its relation to the locale of operations, the stockage of certain maps can indicate the nature, location and scope of planned operations. Strict security measures are therefore necessary for the procurement, stockage, distribution and destruction of map supplies.

c. Maps are subject to rapid obsolescence, particularly with regard to cultural features. Unlike most standard supply items, maps of a given edition cannot be used until stocks are exhausted, if a later edition is available. Earlier editions must be removed from supply channels upon receipt of sheets with a later edition number.

d. Because of their geographic uniqueness and rapid obsolescence, stocking the necessary maps far in advance of an operation is not always feasible. Hence, supply methods must be efficient and flexible, to respond adequately to military needs without wasteful overstocking.

F-2. Responsibilities

The responsibilities for topographic programs in the Department of Defense are described in detail in FM 5-146. Briefly, these are as follows:

a. The Defense Intelligence Agency (DIA) manages the DOD mapping and charting programs.

b. The Army mapping program is directed by the Assistant Chief of Staff for Intelligence (ACSI).

c. The Chief of Engineers is responsible for the execution of the Army mapping program.

(1) The U.S. Army Topographic Command (TOPOCOM), functioning under the command of the Chief of Engineers, is the principal Army agency for the production, storage and distribution of maps. It operates the National Topographic Map Inventory Control Point (NTMICP), which has world-wide cognizance of map supply, and publishes the Map Supply System Catalogs.

(2) Topographic Map Inventory Control Points have been established by TOPOCOM within CONUS, and by Army theater commanders within each overseas theater.

d. The theater army G2 is responsible to the theater army commander for mapping and geodetic plans, policies, and product requirements.

e. The theater army engineer furnishes technical advice and assistance to the G2 on all matters pertaining to the procurement, production, storage and distribution of maps and related materials.

f. In the theaters, the TMICP's are responsible for the management of theater map supply and distribution, and are contact points with the NTMICP in coordinating map supply policies, programs, and procedures. The principal army map distribution agencies in a theater of operations normally are the following:

(1) The map distribution company of the engineer base topographic battalion operates the base and advanced theater depots.

(2) The map distribution platoon of the engineer topographic battalion, army, operates the map depot of a field army.

(3) The map distribution section of an engineer topographic company, corps, operates the corps map depot.

(4) Engineer map depot detachments augment the service of the principal map distribution agencies and perform special map distribution assignments.

F–3. Map Allowances

a. Computing Allowances. Map requirements for a command are computed by the engineer under the staff supervision of G2. These computations are based on units involved, anticipated operations, and pace of operations. Unit allowances and methods of computing map requirements are contained in FM 101–10–1.

b. Types of Issue. Map allowances are categorized according to the type of issue being made. These types are—

(1) *Initial issue.* This refers to the primary distribution of maps to a unit for a particular area of operation. It is expressed in terms of the number of copies of each map required, and varies according to scale and type.

(2) *Replenishment issue.* To cover losses and copies consumed in operations, a supplemental issue based on a percentage of the initial allowance, is distributed.

(3) *Replacement issue.* Replacement is the recall or destruction of obsolete maps, and substitution of new editions. Replacements are made on the same basis as initial issue.

F–4. Map Depots

a. Sites. Map depot sites are located to provide security and operational efficiency. Convenience to a headquarters is secondary to proximity to transportation facilities. Under tactical conditions, provision for concealment, camouflage, and dispersion must be made. Access to the depot should be easy and well marked, and facilities for loading and unloading must be provided. Depots handling large quantities of maps must be located near a major transportation facility, e.g., railroad siding, main roadway, airport, or harbor.

b. Depot Layout. The layout of a map depot must be carefully planned to carry out the major operations of receiving, storing, and shipping maps, and the necessary administrative functions. Aisles should be wide enough to permit easy maneuver of forklift trucks to move map stocks. Planning should allot space for future expansion of depot stocks resulting from new mapping, additional coverage, enlargement of the depot's area of responsibility, or operational requirements. The layout must conform to the building chosen to house it, and will be determined in part by the map stockage plan for the theater. The layout of a typical map depot is shown in figure F–1.

c. Stock Arrangement and Shelving.

(1) Maps are stored in bulk quantity in boxes or on skids as received. For distribution purposes, a certain amount of stock must be kept on shelves. Bulk stocks are stored according to normal warehousing procedures. Boxes or skids are identified and arranged so they can be readily located and removed when needed.

(2) Shelves can be made from locally procured materials. Another method is to use the shipping boxes (fig. F–2) in which the maps are sent. When opening the box, remove only one end section. Retain this section; it can be used to reseal the box. The boxes can be stacked as high as the floor-loading capacity will permit. Each box can be subdivided to provide additional shelf space. Rows and columns of shelves should be identified by letters or numbers and keyed to stock indexes and records.

(3) Maps of the same series should be stored in one area. A logical arrangement based on map series, and sheet numbers within each series, is the most efficient method. A similar method should be used for security areas.

F–5. Depot Operations

a. Stock Control. The efficiency of a map depot depends primarily on the adequacy of its stock-control system. A reference system that shows what maps are in the depot, the number of copies on hand, and the location within the depot of each map, is essential for maintaining control. In addition, a continual inventory must be employed to provide a constant check on map-stock levels. Records of issue are needed to control distribution. Accounting records vary according to the size of the depot, its permanency, the volume and number of items handled, the rate of turnover, and the military situation, but they should be kept as simple as possible. Complicated records waste time, and eventually become unreliable.

b. Records.

(1) *Map locator card.* Map locator cards are necessary to indicate the physical location of all map stock within the depot. A sample card is shown in figure F–3.

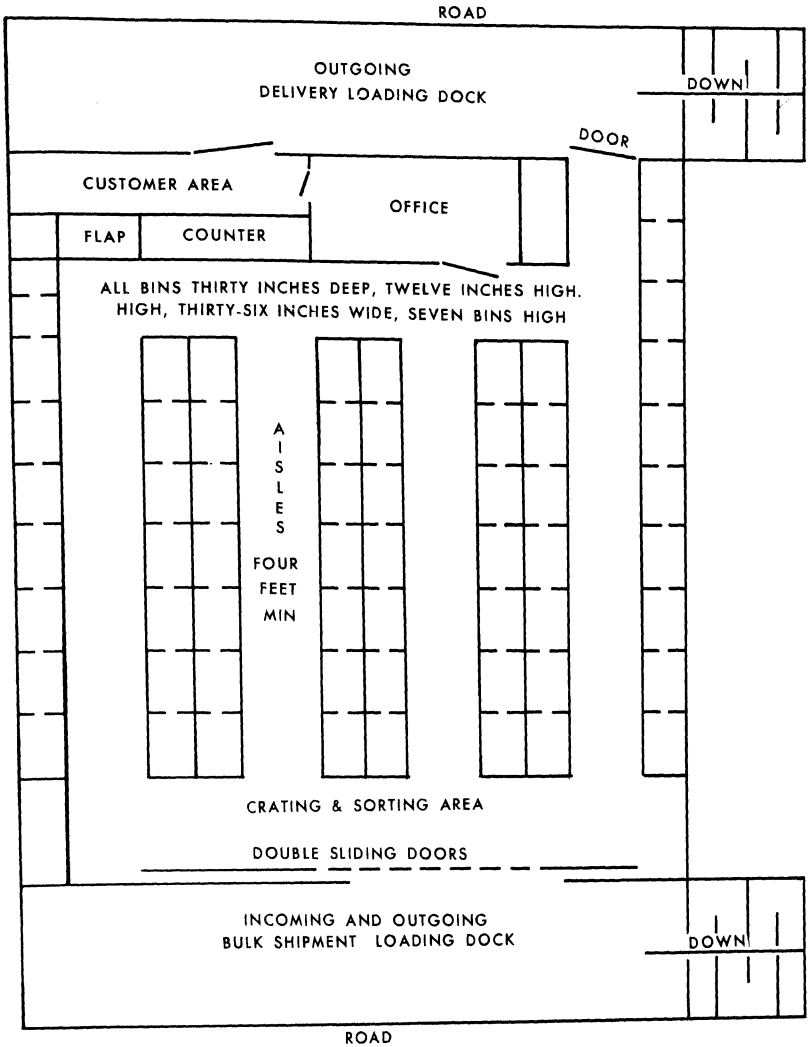
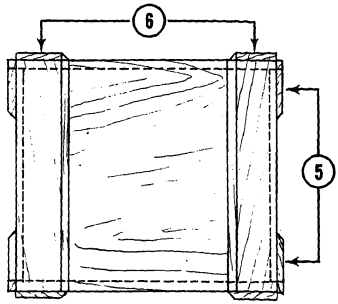
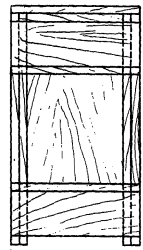


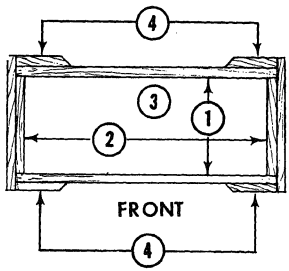
Figure F-1. Typical depot layout.

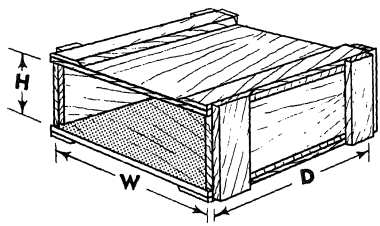


PLAN



SIDE





SPECIFICATIONS		
ITEM	REQ'D	DIMENSIONS
1	2	DIMENSIONS WILL VARY. INSIDE DIMENSIONS
2	2	ARE TAILORED TO MAP SIZE, ALLOWING ½ INCH
3	2 (*1)	SPACE ON EACH SIDE. HEIGHT IS BASED ON
4	4	8" PER 1500 MAPS. MATERIAL IS 1" STOCK.
5	4	NAILS MAY BE USED. ASTERISKS DENOTE
6	4 (*2)	REQUIREMENTS IF BOXES ARE USED AS SHELVES WITH
		ENDPIECE OMITTED.

Figure F-2. Map boxes.

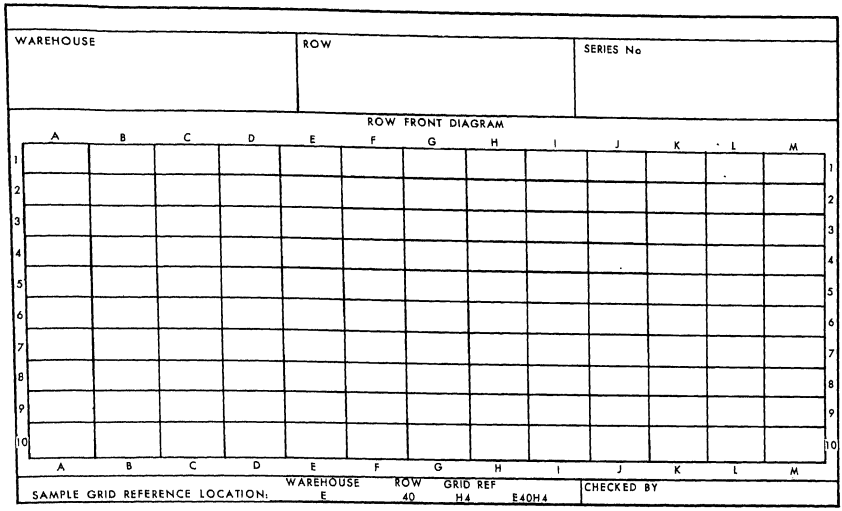


Figure F–2. Map locator card.

(2) *Map indexes.* A map index is a small-scale map over which is printed the sheet outlines of all maps in a given series. The index also shows the series number and scale, individual sheet numbers, sheet numbering system, and other information pertinent to the series. Map indexes for all standard series are published by TOPOCOM. Maps available in a depot can be indicated on map indexes by handmarking, or by printing on a press.

(3) *Map catalog.* A map catalog is a collation of map indexes which shows all the maps stocked by a depot. TOPOCOM publishes a series of Map Supply System Catalogs, showing the available map coverage for all areas of the world.

(4) *Stock control.* A record must be kept to account for all maps or other items received or issued. These records are maintained on a card similar to that shown in figure F–4. A separate card is kept for each item stocked. In depots where a large volume of maps is handled, records can be simplified by treating shelf stock as items issued. For example, a map would be reordered when the bulk stock minus the shelf stock is less than the reorder level, since the shelf stock is considered as items issued. Many other systems are possible and for large operations of any permanence, a machine record system is most advantageous.

(5) *Inventory.* Although a stock record system provides for a continual inventory, inevitable errors in accounting require a periodic physical inventory. Care should be exercised to prevent excessive counting merely for the sake of maintaining overprecise records. Hand counting should never be done except when actually required. For most inventory purposes, measurement of the map stocks provides a sufficiently accurate count. High wet strength and coated stock paper measure 4 inches and 3.5 inches per 1,000 copies respectively. Markers should be inserted in all bins so that the approximate current stock level can be obtained at a glance.

c. Receiving. Incoming map stocks are temporarily stored in the depot receiving area. Here they are segregated by map series or by types, checked and counted. Segregation facilitates the tally and promotes accuracy. Since shipping documents can be unreliable, accurate depot receiving procedures are essential. Four steps normally are used to prepare maps for distribution:

(1) *Unpacking.* Remove crating and outer cover.

(2) *Checking.* Check maps against shipment documents.

WAREHOUSE ☐N.D ☐S.D
LOCATION
REPORT

STOCK LEVEL

OPN LEVEL
R/P
RES LEVEL

☐ AFFE SERIES
☐ AMS SHIPPED
☐ CMS
☐ EDITION
BI-L

NUMBER VOUCHER		RECEIVED	SHIPPED	IN STOCK	VOUCHER NUMBER	RECEIVED		IN STOCK
					SPECIAL INSTRUCTIONS			

Figure F–4. Stock control card.

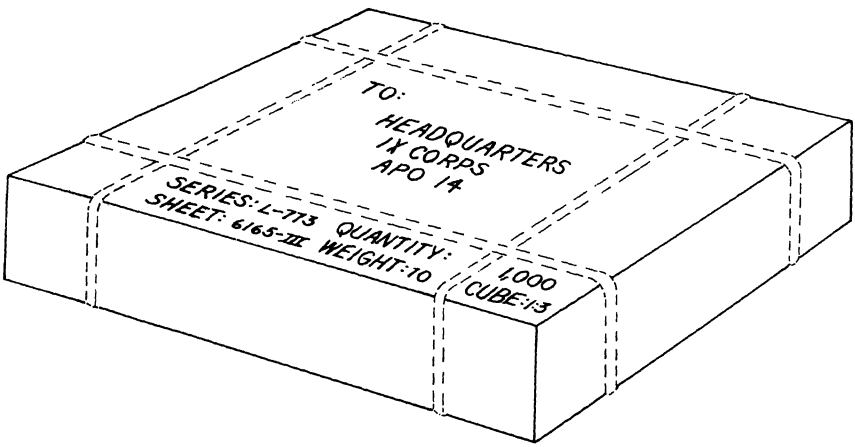


Figure F–5. Flat map package.

(3) *Sorting.* Sort maps by series and sheet.

(4) *Transfer.* Move to storage area.

d. Packaging and Shipping.

(1) *Packaging methods.* Small map orders can be processed in the storage area by using mobile wrapping tables; larger shipments must be removed to the shipping area for processing. Packaging must insure that the maps will arrive at their destination in a serviceable condition and must provide the maximum protection with a minimum expenditure of time and materials. When map boxes are unavailable, two alternate methods of packing can be used—flat map bundles and rolled bundles:

(*a*) The flat map package (fig. F–5), containing 1,000 maps, should be used for air shipment, since it is easily secured in cargo aircraft. This type of bundle is also serviceable for rail, motor, or water shipments when palletized.

(*b*) The rolled package (fig. F–6), containing 250 to 750 maps, is serviceable for local rail shipments, postal, or water shipments involving extensive handling. Shipments involving numerous transshipments should be made in wooden boxes or in box pallets.

(*c*) These two types of bundles are durable, permit easy handling, and give reasonable protection. Flat packaging is recommended when maps are to be overprinted. Roll packages are best for airdrops, but special wrapping is necessary.

(*d*) Steel strapping is the most durable binding material. High tensile strength pressure-sensitive tapes are useful, but do not produce the rigid bundles that can be obtained with steel strapping. Sandbags can be used as emergency map containers by inserting a roll of maps in the sandbag and then lacing the opening.

(2) *Marking.* Packages are marked on the outside to indicate the contents. These markings include series number, sheet, number, and quantity. Addresses must be checked for accuracy and conspicuously located on packages. Addresses and markings are coded as required for security.

e. Security. Classified material is handled in accordance with AR 380–5.

f. Obsolescence and Retirement of Map Stock. Obsolete map editions should be immediately removed from bulk and shelf stock as new editions are received. Maps are retired as directed by higher headquarters when a cutback in holdings is directed. Due to the residual intelligence value of obsolete maps, most of them are cut finely or shredded. Normally, obsolete and retired map stocks, which are not sensitive, are used for printing of forms, charts, and posters. If used fo other purposes, they must be voided or cut up int small segments. Special care must be taken tha voided stock of one country is not circulated in another.

g. Emergency Destruction of Maps and Map

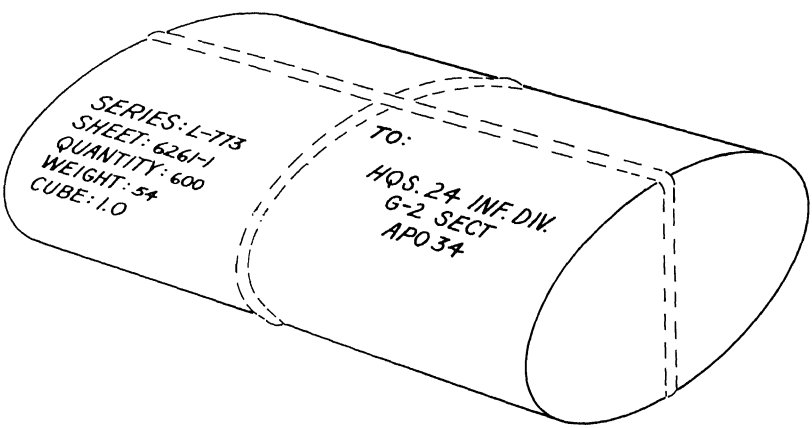


Figure F–6. Rolled map package.

Depots. Destruction plans should be included in the unit SOP and kept up to date. Experience has proven that map destruction is a difficult operation, since even small quantities of maps may require days to burn. Destruction of maps by blasting requires large quantities of explosives. Refer to FM 5–25 for recommended charges. Advanced planning can overcome many of these difficulties.

APPENDIX G
SUPPLEMENTAL TABLES

Table G-1. Weights and Measures

LENGTH:
- 1 inch = 2.54 centimeters
- 1 foot = 30.48 centimeters
- 1 mile = 1,760 yards = 5,280 feet = 63,360 inches = 1.60935 kilometers
- 1 centimeter = .3937 inch
- 1 meter = 39.37 inches = 3.281 feet
- 1 kilometer = 3280.83 feet = .621372 mile
- 1 Angstrom = .001 micron = .00000000394 inch

WEIGHT (avoirdupois):
- 1 ounce = 437.5 grains = 28.35 grams
- 1 pound = 16 ounces = .4536 kilogram
- 1 gram = 15.43 grains = .035 ounce
- 1 kilogram = 2.205 pounds = 35.274 ounces

ELECTRICAL:
- 1 kilowatt (kw) = 1,000 watts = 1.34 horsepower
- 1 kilowatt hour (kwh) = 1,000 watts for 1 hour = 3415 btu (heat)
- 1 kilovolt-ampere (kva) = 1,000 volt amperes

CAPACITY (liquid):
- 1 fluid ounce = 8 drams = 480 minims = 29.57 cubic centimeters
- 1 quart = 2 pints = 57.75 cubic inches = .946 liter
- 1 gallon = 4 quarts = 231 cubic inches = 3.785 liters
- 1 cubic centimeter = 16.23 minims
- 1 liter = 1,000 cubic centimeters = 33.815 fluid ounces

Table G-2. Temperature Conversion

°F. (degrees Fahrenheit)	°C. (degrees Centigrade)	°F. (degrees Fahrenheit)	°C. (degrees Centigrade)
−40	−40	90	32
−30	−34	95	35
−20	−29	100	38
−10	−23	105	41
0	−18	110	43
10	−12	115	46
20	−7	120	49
30	−1	125	52
32	0	130	54
35	2	140	60
40	4	150	66
45	7	160	71
50	10	170	77
55	13	180	82
60	16	190	88
65	18	200	93
67	19.5	210	99
70	21	212	100
75	24	220	104
80	27	230	110
85	29	240	116

Table G-3. Specific Gravity (Liquids Heavier Than Water)

°Baumé	Specific gravity	°Baumé	Specific gravity
0	1.000	21	1.169
1	1.007	22	1.179
2	1.014	23	1.189
3	1.021	24	1.198
4	1.028	25	1.208
5	1.036	26	1.219
6	1.043	27	1.229
7	1.051	28	1.239
8	1.058	29	1.250
9	1.066	30	1.261
10	1.074	31	1.272
11	1.082	32	1.283
12	1.090	33	1.295
13	1.099	34	1.306
14	1.107	35	1.318
15	1.115	36	1.330
16	1.124	37	1.343
17	1.133	38	1.355
18	1.142	39	1.368
19	1.151	40	1.381
20	1.160	41	1.394

Table G-4. Relative Humidity

(Barometric Pressure 29.92 Inches;
Air Movement Past Psychrometer 600 Feet Or More Per Minute.)

DRY BULB TEMPERATURE °F.

WET BULB TEMPERATURE °F.	34 36 38	40 42 44 46 48	50 52 54 56 58	60 62 64 66 68	70 72 74 76 78	80 82 84 86 88	90 92 94 96 98	100 102 104 106 108	110
50	5 16 27	38 49 61 74 87	100						
52	9 19	29 40 51 63 75	87 100						
54	3 12	22 32 42 53 64	76 88 100						
56	7	16 25 34 44 55	65 76 88 100						
58	1	10 18 27 37 46	56 66 77 89 100						
60		5 13 21 30 39	48 58 68 78 89	100					
62		8 16 24 32	41 50 59 69 79	89 100					
64		4 11 18 26	34 43 51 60 70	79 90 100					
66		7 14 21	29 36 44 53 61	71 80 90 100					
68		3 10 16	23 31 38 46 54	62 71 80 90 100					
70		6 12	19 25 33 40 48	55 64 72 81 90	100				
72		3 9	15 21 28 34 42	49 57 65 73 82	91 100				
74		5	11 17 23 29 36	43 50 58 65 74	82 91 100				
76		3	8 13 19 25 31	38 44 51 59 66	74 82 91 100				
78			5 10 16 21 27	33 39 46 53 60	67 75 83 91 100				
80			3 7 12 18 23	29 35 41 47 54	61 68 75 83 91	100			
82			4 10 14 20	25 30 36 42 48	55 61 69 76 84	92 100			
84			1 7 12 16	21 26 32 37 43	49 56 62 69 76	84 92 100			
86			5 9 14	18 23 28 33 39	44 50 57 63 70	77 84 92 100			
88			3 7 11	15 20 25 30 35	40 46 51 57 64	70 77 85 92 100			
90			1 5 9	13 17 22 26 31	36 41 47 52 58	65 71 78 85 92	100		
92			3 7	11 15 19 23 28	32 37 42 48 53	59 65 72 78 85	92 100		
94			5	9 12 16 20 24	29 33 38 43 49	54 60 66 72 79	85 93 100		
96			3	7 10 14 18 22	26 30 35 39 44	50 55 61 66 73	79 86 93 100		
98			1	5 8 12 15 19	23 27 32 36 40	45 50 55 61 67	73 79 86 93 100		
100				3 7 10 13 17	21 24 28 33 37	41 46 51 56 62	68 73 80 86 93	100	
102				1 5 8 11 15	18 22 26 30 34	38 42 47 52 57	62 68 74 80 86	93 100	
104				3 7 10 13	16 20 23 27 31	35 39 43 48 53	58 63 69 74 80	87 93 100	
106				5 8 11	14 17 21 24 28	32 36 40 44 49	53 58 64 69 75	81 87 93 100	
108				3 7 10	12 16 19 22 25	29 33 37 41 45	49 54 59 64 70	75 81 87 93 100	
110				5 8	11 14 17 20 23	26 30 34 38 42	46 50 55 60 65	70 75 81 87 93	100
112				4 7	9 12 15 18 21	24 27 31 35 38	42 47 51 55 60	65 70 76 81 87	94
114				6	8 11 13 16 19	22 25 28 32 35	39 43 47 52 56	61 66 71 76 82	88
116					7 9 12 14 17	20 23 26 29 33	36 40 44 48 52	57 61 66 71 76	82
118					6 8 11 13 16	18 21 24 27 30	34 37 41 45 49	53 57 62 67 72	77
120					6 9 12 14	17 19 22 25 28	31 34 38 41 45	49 53 58 62 67	72
122					8 10 13	15 18 20 23 26	29 32 35 39 42	46 50 54 58 63	67
124					7 9 11	14 16 18 21 24	27 30 33 36 39	43 47 50 54 59	63
126					8 10	12 15 17 19 22	25 27 30 33 37	40 44 47 51 55	59
	34 36 38	40 42 44 46 48	50 52 54 56 58	60 62 64 66 68	70 72 74 76 78	80 82 84 86 88	90 92 94 96 98	100 102 104 106 108	110

Table G-5. Decimal-Equivalents

Fraction				Inches	Mm.	Fraction				Inches	Mm.
			1/64	.016	.40				33/64	.516	13.10
		1/32		.031	.79			17/32		.531	13.49
			3/64	.047	1.19				35/64	.547	13.89
	1/16			.063	1.59		9/16			.563	14.29
			5/64	.078	1.98				37/64	.578	14.68
		3/32		.094	2.38			19/32		.594	15.08
			7/64	.109	2.78				39/64	.609	15.48
1/8				.125	3.18	5/8				.625	15.88
			9/64	.141	3.57				41/64	.641	16.27
		5/32		.156	3.97			21/32		.656	16.67
			11/64	.172	4.37				43/64	.672	17.07
	3/16			.188	4.76		11/16			.688	17.46
			13/64	.203	5.16				45/64	.703	17.86
		7/32		.219	5.56			23/32		.719	18.26
			15/64	.234	5.95				47/64	.734	18.65
1/4				.250	6.35	3/4				.750	19.05
			17/64	.266	6.75				49/64	.766	19.45
		9/32		.281	7.14			25/32		.781	19.84
			19/64	.297	7.54				51/64	.797	20.24
	5/16			.313	7.94		13/16			.813	20.64
			21/64	.328	8.33				53/64	.828	21.03
		11/32		.344	8.73			27/32		.844	21.43
			23/64	.358	9.13				55/64	.859	21.83
3/8				.375	9.53	7/8				.875	22.23
			25/64	.391	9.92				57/64	.891	22.62
		13/32		.406	10.32			29/32		.906	23.02
			27/64	.422	10.72				59/64	.922	23.42
	7/16			.438	11.11		15/16			.938	23.81
			29/64	.453	11.51				61/64	.953	24.21
		15/32		.469	11.91			31/32		.969	24.61
			31/64	.484	12.30				63/64	.984	25.00
1/2				.500	12.70	1				1.000	25.40

GLOSSARY

Aberration—Failure of an optical system to bring all light rays received from a point object to a single image point or to a prescribed geometric position.

Abrasive—Hard material used for grinding softer materials. Used in brush-surfacing to roughen the plate surface.

Absorption—Assimilation of one substance into another. In optics, the partial suppression of light passing through a medium such as a color filter which transmits only the color of the filter, all other colors being absorbed.

Accelerator—Any substance used to shorten development time or speed the chemical reaction of developing agents with exposed photographic emulsions. Usually an alkali. The degree of alkalinity or pH determines the time necessary for full development and the degree of density and contrast possible.

Acetate—A nonflammable plastic sheeting used as a base for photographic films or as a drafting base for color separation manuscripts and overlays.

Acetic acid, CH_3COOH—Glacial is over 99 percent pure; 28 percent is made by diluting 3 parts glacial acetic acid to 8 parts water. Used as counteretch in plate processing. Also used as a shortstop to neutralize alkaline developers.

Achromatic—Without color. A lens which transmits light of all colors equally is achromatic.

Acid—A compound containing hydrogen which can be replaced by certain metals to form a new compound called a salt. Most acids have a sour taste and will change blue litmus paper to red.

Across the grain—The direction opposite to that in which the paper fibers are aligned. Contrasted with grain direction.

Actinic light—Light which is capable of causing photo-chemical changes in a sensitized emulsion.

Additive process—A photographic color process which produces color by combining separate primary colors to form white light.

Adsorption—The adhesion of molecules in solution to the surface of a solid.

Aerial photograph—A photograph of a portion of the earth's surface taken from the air.

Affinity—Having an inherent attraction for. Lithographic plates have an affinity or natural attraction for grease or ink.

Air bells or air bubbles—Small air bubbles which cling to the surface of an emulsion during processing, leaving small spots unaffected by the solution. Usually prevented by agitation of the film or paper in the developing solution.

Alkali—A substance which can neutralize acids. Used as an accelerator in photographic and plate processing developers.

Alum, $AlK(So_4)_2$—Aluminum potassium sulfate (potassium alum). Salt used to toughen colloid films in photography, and in preparing lithographic plates for drafting.

Ammonia process—*See* Diazo compounds.

Ammonia water—Ammonium hydroxide, NH_3OH. A strong alkaline solution of 28–29 percent ammonia gas (NH_3) dissolved in water. Used to alkalize plate-processing sensitizer and to soften exposed sensitizer for development.

Anastigmat—A lens which has been corrected for astigmatism and, therefore, focuses vertical and horizontal lines with equal brightness and definition. Anastigmatic lens are also free from most common aberrations.

Angle of field—A property of a lens. The angle subtended by lines that pass through the center of the lens and locate the diameter of the maximum image area within the specified definition of the lens. Lenses are generally classified according to their angles of coverage, i.e., narrow-angle, wide-angle, normal-angle, superwide angle.

Angstrom unit (Å).—A unit of measure equal to one ten-thousandth of a micron, one-tenth of a millimicron, or one ten-millionth of a millime-

ter. Commonly used to express the length of light rays.

Anhydrous (*anhy*)—Completely lacking water, especially water of crystallization. Chemicals from which water has been removed. Same as desiccated.

Aniline—Amino-benzene. An oily, organic compound derived from coal tar which is the base compound of most photographic developing agents.

Antihalation backing—An opaque coating applied to the back of film to prevent reflection from the back surface of the film base.

Aperture—The lens opening that regulates the amount of light reaching the film.

Aplanatic lens—Lenses which have been corrected for spherical and chromatic aberration and which will give reasonably sharp definition at full aperture.

Apochromatic lens—Lenses which are free from spherical and chromatic aberrations. A true apochromatic lens is corrected for three or more colors.

Argentometer—An instrument used to measure the concentration of silver nitrate in a silver sensitizing bath.

Asphaltum—Mineral pitch. Used in various inks and varnishes as a protective coating in plate processing, and to make the printing image on the press plate permanently ink receptive.

Astigmatism—A lens defect or aberration which will not permit an accurate and simultaneous focus of vertical and horizontal lines at locations off the principal axis of the lens near the extremes of the angle of field.

Autoscreen film—A photographic film embodying a halftone screen which automatically produces a halftone negative from continuous-tone copy.

Avoirdupois—A system of weights and measures consisting of grains, ounces, pounds, fluid ounces, and quarts. Commonly used in the United States and Great Britain.

Axis—*See* Optical axis.

Backup—An image printed on the reverse side of a sheet already printed on one side. Also the printing of such images.

Base color—The first color printed of a polychrome map to which succeeding colors are registered.

Baumé—A unit of measure used to express the density of liquids.

Bearers—Steel rings on the ends of press cylinders that make rolling contact for proper meshing of the driving gears. Bearers also provide a fixed base for determining the packing of plate and blanket.

Bite—1. A surface characteristic of paper which causes it to accept ink, pencil, or other impressions. 2. Gripper bite, the amount of paper that extends beneath the press gripper, sometimes called gripper margin.

Blanket dust—A mixture of 50 percent French chalk and 50 percent powdered sulfur dusted on offset press blankets to remove tackiness.

Blanket, offset—A rubberized blanket on a fabric base, clamped around the blanket cylinder. Receives inked impression from plate and transfers it to paper.

Bleed—1. Printing area that extends to the edge of the sheet or page after it is trimmed. 2. A slight extension or thickening of printing detail, usually of the lighter color or tint, which produces slight color overlap and prevents a white gap between colors owing to slight variations in register. 3. A lithographic ink pigment which dissolves in the fountain etch and causes tinting.

Blind image—A printing image that will not accept ink.

Blocking—Adhesion between paper sheets, preventing paper feeding in press.

Blueline—A nonreproducible blue image or outline usually printed photographically on paper or plastic sheeting, and used as a guide for drafting, stripping, or layout.

Blueline board—A drafting surface mounted on metal or board, then coated with an iron sensitizer, yielding a nonphotographic blue image after contact exposure through a negative and development in water.

Blueprint—A sensitized contact paper yielding a blue image upon development with water. The term also refers to a blue nonprinting image on a metal lithographic plate.

Bromide paper—A photographic printing paper with an emulsion composed largely of silver bromides.

Buffer—A chemical agent added to a solution to stabilize it against rapid breakdown. Used in

offset-press fountain solutions to maintain constant pH.

Burn—The process of exposing a press plate.

Burnish—To remove small unwanted imagery from a press plate by use of etchstick or snakeslip.

Calender—The process of making a glossy surface on paper or cloth by pressing between rollers.

Camera—An optical device for projecting an image of an external subject onto a photographically sensitized film inside a lightproof box.

Canada balsam—An adhesive having approximately the same refractive index as glass. Used to join lens elements and screens.

Carbon—Chemical element in black carbon rods. When electricity flows through these rods, the carbon combines with oxygen in the air, producing an arc of intense light across the rod tips.

Carrier—A viscous liquid (usually a resin) in which a pigment or blend of pigments is mixed to produce lithographic printing ink.

Cartographic film—Film with a dimensionally stable base, used for map negatives or positives.

Cartography—The art and science of expressing graphically, by maps and charts, the known physical and cultural features of the earth or of another celestial body.

Catching up—A lithographic term used to indicate that nonimage areas of a pressplate are beginning to take ink.

Caustic soda—*See* Sodium hydroxide.

Cellulose tape—A strong adhesive on a cellulose base. Also known as Scotch tape.

Chalk—Powdered limestone used to dry printing ink.

Chalking—Improper drying of printing ink which causes the pigment to dust off, due to lack of binding vehicle, caused by too rapid absorption of the vehicle into paper.

Characteristic curve (photography)—A curve showing the relationship between exposure and resulting density in a photographic image, usually plotted as the density (D) against the logarithm of the exposure (logE) in candle-meter-seconds. Also called the *H and D curve*, the *sensitometric* curve, the *D log E* curve, *time-gamma* curve, or *density-exposure* curve.

Chromatic aberration—The distortion of rays of various wavelengths or colors through an uncorrected lens. See *lateral* and *longitudinal chromatic aberration.*

Circular screen—A circular-shaped halftone screen which enables the cameraman to obtain the proper screen angles for halftone work without disturbing the copy.

Coated stock—Paper stock which has been coated with a mineral substance such as clay, satin white, titanium oxide, or one of several other substances which have an affinity for ink. Casein is used as the adhesive which holds the coating onto the body stock.

Coating—1. Term applied to the mineral substances used to cover the surface of paper when preparing coated stock. 2. The operation of applying the mineral substance to the paper. 3. In photography and photomechanics, the application of varnishes and other mixtures to plates and negatives; also application of light sensitive solutions to plate surfaces.

Collate—To assemble pages, signatures, plates, etc., in correct sequence before binding.

Color corrected lens—A lens which has been constructed to bring all light waves to the same focus plane.

Color filter—A sheet of dyed glass, gelatin, or plastic used in photography to absorb certain colors and permit better rendition of others. A color filter permits certain wave lengths of light to pass through and absorbs others.

Colorproof—A single copy of each color of a multicolor printing, or a composite copy of all the colors.

Color pulls—Single impressions, printed in black, from a set of two or more color plates. The "pulls" are photographed to make new negatives, or used as field check sheets or edit sheets.

Color separation—1. A photographic negative exposed through a filter so that only one of the primary colors is recorded. 2. The process of preparing separate drawings, engravings, or negatives for each color required in the production of a multicolor lithograph.

Combination plate—Halftone and line work on one plate. Also two or more subjects combined on the same plate.

Comparator—A precision optical instrument used to determine the rectangular coordinates of a

point with respect to another point on any plane surface, such as a photographic plate.

Complementary colors—Any two opposite (or contrasting) light colors which, when combined, produce white or gray. A mixture of any two primary colors is the complement of the remaining primary. In printing, complementary colors either accentuate or neutralize each other.

Composite—Reproduction from a successive series of images. A proof made by exposing several color-separation negatives on a single sheet of paper or plastic.

Contact negative—A negative made by placing an unexposed photographic emulsion in contact with a positive, exposing it to light, and then processing to develop the image.

Contact positive—A positive made by placing an unexposed photographic emulsion in contact with a negative, exposing it to light, and then processing to develop the image.

Contact printing frame—A device for holding a negative or positive transparency in contact with sensitized material for exposure to light. The light source may or may not be a separate element.

Contact screen—A halftone screen made on a film base and used in direct contact with the film or plate to obtain a halftone pattern from a continuous-tone original. See *Magenta contact screen.*

Contact size—Printing to the same size as the original. Often referred to as one-to-one (1:1). See *Scale of reproduction.*

Continuous tone—An image which has not been screened and contains unbroken, gradient tones from black to white, in either positive or negative form.

Contrast—The actual difference in density between the highlights and the shadows on a negative or positive. Contrast is not concerned with the magnitude of density, but only with the difference in densities. When there is little difference in the densities of light and dark areas, the copy is said to be "flat". Copy in which the differences are strongly accentuated is referred to as "contrasty."

Copy—The original manuscript or text furnished for reproduction. Line copy is composed of lines or dots of solid color. Tone copy is composed of tones or shades of color.

Copy preparation—The assembling into proper position of the text and art to be photographed for reproduction.

Corner marks—*See* Register marks.

Counter-etch—To remove, with certain diluted acids, impurities from a lithographic plate, making it receptive to the inked image.

CP—*Abbreviation for* "Chemically Pure."

Crop—To trim or cut off superfluous parts of an image to improve balance and composition, or to emphasize certain portions. Usually accomplished by masking techniques.

Crossline glass screen—A halftone screen composed of straight opaque lines which cross at right angles, thus forming transparent squares or screen apertures, as opposed to the straight-line screen, composed of lines running only in one direction.

Crystals—Solidification of a chemical element, compound, or mixture into particles of definite characteristic geometric form.

Culture—Features of the terrain that have been constructed by man, such as roads, buildings, railroads, canals.

D log E curve—*See* Characteristic curve.

Dampeners—Cloth-covered rollers that distribute the dampening solution to the pressplate.

Darkroom—A darkened room used for the development of light-sensitive emulsions.

Definition—Degree of clarity and sharpness of an image. *See* resolving power.

Densitometer—An electric instrument for accurately measuring optical density or tone values. Transmission densitometers measure the full density range of negatives; reflection densitometers measure the reflection range of opaque copy.

Density—The quantity of metallic silver (or dyes) per unit area in negatives and positives. It is defined strictly as the logarithm of the optical opacity, where the opacity is the ratio of the incident to the transmitted (or reflected) light. It varies with the use of scattered or specular light.

Depth of field—The distance between the points nearest and farthest from the camera which are acceptably sharp.

Depth of focus—The distance that the focal plane can be moved forward or backward from the point of exact focus, and still give an image of acceptable sharpness.

Desensitizing—Chemical treatment of a lithographic plate to make the nonimaged areas unreceptive to ink.

Developer; Development—1. The chemical agent and the process employed to render latent photographic images visible after exposure to light. 2. In lithographic platemaking, the removal of the unhardened diazo coating (nonimage areas).

Developing ink—A greasy liquid applied to plate images to protect the image and keep it ink receptive while the plate is processed.

Diameter enlargement—The degree of enlargement of original copy. A one-diameter enlargement of a 4″ x 5″ original would be 8″ x 10″.

Diaphragm—An adjustable aperture which controls the amount of light passing through a lens.

Diazo compounds—Dye compounds that are sensitive to light. Exposure decomposes the compound, preventing dye-coupling. Unexposed areas are developed by exposure to ammonia fumes or alkaline solutions.

Differential shrinkage—The difference in contraction along and across the grain structure of photographic film, paper, and map stock.

Diffraction—The bending of light waves around the edges of opaque objects. Due to diffraction, a point of light seen or projected through a circular aperture will appear as a bright center surrounded by light rings of gradually diminishing intensity. The formation of halftone dots is based on this phenomenon.

Diffusion—A type of reflection in which the reflected rays are scattered in all directions.

Dimension marks—Marks placed on copy, or in the margin, showing the overall dimension of the image.

Dimensional stability—Ability to maintain size; resistance of paper or film to dimensional changes caused by changes in moisture content and temperature.

Direct positive—A positive image obtained without the use of a negative.

Dodging—The process of holding back light from certain areas of a sensitized surface to avoid overprinting those areas.

Dope—Water fountain solution; a general term applied to lithographic ink conditioners, reducers, and varnishes.

Dot-etching—Reducing the size of opaque dots in specific areas of a halftone negative or positive by applying a chemical reducer locally to those areas with a cotton swab.

Dots, halftone—Minute, symmetrical subdivisions of printing image formed by a halftone screen.

Double burn—*See* Multiple burn.

Drainage—In mapping, all features associated with water, such as shoreline, rivers, lakes, swamps, etc.

Drier—A compound added to printing ink to accelerate drying.

Dropout halftone—A halftone reproduction in which highlights are obtained photographically by use of contact halftone screen or manipulation of the camera exposure through a crossline halftone screen.

Dry plate—A photographic glass plate on whic' the light-sensitive emulsion is exposed in a dı condition.

Ductor roller—Press rollers that have reciprocal as well as rotary movement, used to control the transfer of ink or water from the fountain roller to the distributor roller by alternately contacting each.

Dummy—1. A preliminary drawing or layout showing the position of illustrations and text as they will appear in the final reproduction. 2. A set of blank pages made up to show the size, shape, and general style of a book, booklet, or pamphlet.

Duplicate negative—A negative made from a positive or from another negative. The duplicate negative may be a true reproduction of the original or a reproduction possessing greater or less contrast. The chemical reversal process and duplicating film make it possible to obtain a duplicate negative without an intervening positive copy.

Elevation tints—A method of showing relief on maps and charts by coloring, in different shades, those parts which lie between different levels. *See* Gradient tints.

Embossing—Image swelling on an offset blanket due to absorption of ink solvents. If not exces-

sive, embossing can be removed by washing and hanging the blanket to evaporate the solvent.

Emulsion—Photography. A suspension of either light-sensitive silver salts, diazos, or photopolymers, in a colloidal medium, usually gelatin, used for coating photographic films, plates, or papers.

Emulsion-to-base exposure—A contact exposure in which the emulsion of the copying film is on the side of the film opposite to that in contact with the sheet being copied, producing a copy that is wrong-reading through the base.

Emulsion-to-emulsion exposure—A contact exposure in which the emulsion of the copying film is in contact with the emulsion of the sheet being copied, producing a copy which is right-reading through the base.

Emulsification—Absorption of excessive water by ink, resulting from use of too much drier or water, too little acid, or a poor ink.

Enlargement—A negative, positive, or print copy made at a scale larger than the original. Also called a *blow-up.*

Enlargement diagram—Chart showing the necessary lens extension and copy board extension required for various enlargements.

Equivalent focal length—The distance measured along the lens axis from the rear nodal point of a lens to the plane of best average definition over the entire field, the object being at infinity.

Etch—1. Chemical treatment of plate to make nonpriting areas grease-repellent and water-receptive; 2. To remove selected areas of the emulsion either chemically or manually; 3. An acid solution mixed with the dampening fountain water on an offset press to help control ink on the press plate.

Etch slip—A pencil-shaped abrasive used in removing unwanted marks on a metal pressplate. It is sometimes called a "snakeslip."

Exposure—The total quantity of light received per unit area which may be expressed as the product of the light intensity and exposure time. Also the act of exposing a light-sensitive material to a light source, and exposure time.

Extender—A white or colorless pigment mixed with printing ink to improve working properties or to reduce color intensity. Also used to extend quantity or covering power of ink.

Extension—The distance between the lens and the negative surface.

Face—The emulsion side of a negative or layout plate, or the printing surface of a plate.

Farmer's reducer—A solution containing principally potassium ferricyanide and sodium thiosulfate that slowly dissolves the developed silver image on a photographic emulsion; used to clear fog in transparent areas of negatives or positives, and to reduce halftone dot size.

Felt side—The top or smooth side of paper that is contacted by the felt belt for extraction of moisture during manufacture. This is the correct side of the paper for printing.

Film—A thin, flexible transparent sheet of stable plastic material to which a light-sensitive emulsion has been applied.

Film speed—*See* Speed rating.

Filter—1. A material that selectively withholds some types of material or energy while permitting others to pass. 2. A cotton or cheesecloth pad which permits dissolved colloids to pass, but holds back other insoluble or foreign materials. 3. Colored film or glass that transmits a single color or a range of colors while absorbing others.

Filter factor—A number indicating the increased exposure required for a particular color filter.

Fix—To make permanent the developed photographic image by removing unexposed silver salts in an emulsion without affecting the metallic silver deposited by the developer.

Fixed (Hypo)—*See* Sodium thiosulfate.

Fixing bath—A chemical solution containing sodium thiosulfate, commonly known as "hypo." Used to fix photographic images and to harden the emulsion of film during processing.

Flash exposure—A supplementary exposure given during halftone photography to strengthen the dots in shadow areas. This exposure is made with a small lens aperture to a sheet of white paper hung over the original, or to the rays from a flashlamp.

Flat—1. (lithography) An assembly of photographic negatives or positives on goldenrod paper or vinyl acetate for contact exposure with a sensitized metal press plate. May contain art as well as text. 2. (photography) Lacking in contrast.

Focal length—The distance between the optical center of a lens and the point at which an object image is in sharp or critical focus.

Focal plane—The plane perpendicular to the lens axis on which the rays of light projected through the lens are focused; the surface represented by the light-sensitive film or plate.

Focus—The point toward which rays of light converge to form an image after passing through a lens. Also defined as the condition of sharpest imagery.

Fog—The veil or cloudiness on transparent areas of negatives that prevents complete passage of light, due either to stray light or to improperly compounded chemical solutions.

Formalin—A solution of formaldehyde gas ($HCHO$) in water (37–40 percent). A powerful reducing agent used as a preservative and a hardener for photographic emulsions.

Form rollers—The ink and dampener rollers on the offset press that contact the press plate.

Fountain solution—A desensitizing solution of water, gum arabic, and other chemicals used to dampen the lithorgraphic plate and keep the nonprinting areas from accepting ink.

French chalk—*See* Magnesium silicate.

Frilling—The separation of photographic emulsion from its base along the edges of the negative.

Fugitive—A color which does not hold its strength and fades in sunlight.

Galley proof—A proof from type on a galley before it is made up into pages.

Gamma—The tangent of the angle which the straight-line portion of the characteristic curve makes with the log-exposure axis. It indicates the slope of the straight-line portion of the curve and is a measure of the extent of development and the contrast of the photographic material.

Gather—To collect in numerical sequence for binding.

Gear streaks—Parallel tint streaks appearing across printed sheet at same interval as gear teeth on cylinder. Caused by improper underpacking or defective press conditions resulting in difference of surface speed between cylinder and pitch diameter of gears.

Glossy print—A photographic print with a hard, glossy finish usually made by pressing and drying the print with the emulsion surface against an enameled or chromium-plated or polished stainless steel surface.

Glue tone—A trade name for the process of making a dyed image on acetate by means of a bichromated glue coating which is light hardened and dyed.

Goldenrod paper—A clay-coated paper, usually a shade of yellow or red, which is actinically opaque. It is used as a base for layouts, and for blocking out non-printing areas of negatives. Also called *masking paper*.

Gradation—The range of tones from the brightest highlights to the deepest shadows.

Gradient tints—Bands of color tints which represent varying elevation ranges on a map.

Grain—1. The alinement of paper fibers parallel to the movement on the paper machine during manufacture. Also known as machine direction 2. The distribution of silver particles in photographic emulsions and images.

Grained surface—The roughened or irregular surface of an offset printing plate.

Graining—The mechanical roughening or graining of an abrasive into the surface of a pressplate to increase the surface area and improve the water receptiveness of the surface.

Granularity—The graininess of a developed photographic image, evident particularly on enlargements, that is due either to agglomeration of developed grains, or to an overlapping pattern of grains.

Gravure—A printing method in which the ink-bearing area of the printing plate is composed of minute cavities of varying depth. These are filled with a thin ink which is transferred to the paper.

Gray-scale—A strip of standard gray tones, ranging from white to black, used to measure the tonal range of original copy. Also called *step wedge*.

Grid—A system of mutually parallel lines superimposed on aerial photographs, mosaics, and charts, in respect to which points on the ground are located.

Gripper—A small clamp which holds the press sheet as it passes through the press.

Gripper bite—The amount of paper that extends beneath the press gripper. Also known as "gripper margin."

Gripper edge—The leading edge of the press sheet as it travels into the press.

Gripper margin—An unprinted area between the edge of the press sheet and the lead edge of the image area, allotted for the press grippers to hold the press sheet.

Ground glass—The focusing glass in the focal plane of a camera on which the image may be checked for sharpness and size.

Guides—Mechanical stops used in positioning paper sheets on a press.

Gum arabic (gum acacia)—The dried sap of acacia trees. Soluble in water. Used to form a protective and ink-repellent film on the lithographic printing plate and as an adhesive for mosaics, copy layout, or book binding.

Gumming up—Applying a solution of gum arabic to the pressplate to protect it from grease and oxidation.

H and D curve—*See* Characteristic curve.

Halation—A blurring of a photographic image due to reflection of light from the film base. Particularly noticeable in photographs of light objects against a darker background.

Halftone—Any photomechanical printing surface or the impression therefrom in which detail and tone values are represented by a series of evenly spaced dots of varying size and shape, varying in direct proportion to the intensity of the tones they represent.

Halftone screen—A grating of opaque lines on glass, crossing at right angles, producing transparent square apertures between intersections. Used in a process camera to break up a solid or continuous-tone image into a pattern of small dots.

Halftone-tint negative—A negative made by photographing a tint or white through a halftone screen, producing an even screen tint.

Halides (or haloids)—Binary compounds containing any of the following elements: chlorine, bromine, iodine, or fluorine.

Hand proof—In offset lithography, a proof of a plate made on a hand-proof press where operations are manual for inking, dampening, and taking the impression.

Hand roller—A roller made of wood and covered with leather, used for applying ink by hand to a lithographic plate.

Highlight halftone—A halftone reproduction in which the highlights are devoid of dots for accenturation of contrast.

Highlights—Portions of an image from which the greatest amounts of light are reflected.

Hue—The characteristic of a color which is determined by the predominant wavelength of the light it reflects or transmits. Red, yellow, green, blue, purple, and their many intermediates are hue names.

Humidity—A measure of moisture content of air. Relative humidity is percentage of moisture in air at a specified temperature relative to maximum moisture air can hold at that temperature.

Hydrochloric acid, HCl—An acid used in cleaning (counteretching) lithographic press plates.

Hydrogen ion concentration (H)—A measure of degree of acidity or alkalinity of a solution. It is equal to the logarithm of the reciprocal of the excess of hydrogen ions in an acid solution, or the hydroxyl ions in alkaline solutions.

Hydrometer—An instrument for measuring strength or specific gravity of liquids.

Hydroquinone, $C_6H_4(OH)_2$—A reducer used in photographic developer.

Hygrometer—An instrument for measuring atmospheric moisture.

Hygroscopic—The property of materials such as paper and acetate films to absorb or release moisture and, in so doing, to expand or contract.

Hypo—Sodium thiosulfate, also called sodium hyposulfite, a chemical used to fix the image on a photographic plate after it has been developed.

Hypsography—That part of topography dealing with relief or elevation of terrain.

Image—The permanent record of the likeness of any natural or manmade features, objects, and activities reproduced on photographic materials.

Image direction—The image orientation of a photographic negative or positive relative to the position of the emulsion. An image can be either right reading (from left to right), or wrong reading (from right to left) when

viewed through the base (emulsion down). See also *emulsion-to-base; emulsion-to-emulsion; right reading; wrong reading.*

Imposition—Positioning and assembling negatives or positives into printing location on a flat.

Impression—Inked image received by a sheet in a press.

Infrared—Photography: Pertaining to or designating those rays of light just beyond the red end of the visible spectrum, such as are emitted by a hot body. They are invisible to the eye and are detected by their thermal and photographic effects. Their wavelengths are longer than those of visible light and shorter than those of radio waves. Special photographic plates coated with an emulsion which is sensitive to infrared are used in process work for preparing separation negatives of the black.

Ink—A composition of pigments, vehicles, and compounds or greasing agents providing a stiff ink for lithographic printing.

Invar scale—A calibrated metal bar made of a special nickel-steel alloy which has a low coefficient of expansion. Metric measurements are engraved on one side of the bar, and English measurements on the other. It is used to determine or check image size on the focusing glass of a process camera.

Intensify—A term used in photography to denote a process of depositing some metal on the black metallic silver of a negative or positive to increase the density.

Iris diaphragm—An adjustable aperture in the barrel of photographic lenses; the contraction of the aperture resembles that of the iris (pupil) of the human eye, hence its name.

Iron blues—Inks, the pigments of which are derived from iron. Prussian blue, Milori blue, and bronze blue fall into this class.

Jog—Jarring paper into alinement to form a uniform stack.

Key—The principal or master layout or flat used as a positioning guide for stripping up other flats.

Kiss plate—A press plate used to make an addition or correction to a previously printed sheet.

Kiss pressure—The minimum pressure at which proper ink transfer is possible.

Lakes—Inks, the pigments of which are obtained mainly from coal tar dyes.

Laketine—A colorless reducer (magnesia in linseed oil) used in lithographic inks to reduce color strength.

Latent image—The invisible image produced in radiation-sensitive materials which becomes visible upon processing.

Lateral chromatic aberration—A lens aberration which affects the sharpness of images off the axis because different colors undergo different magnifications.

Lay—The arrangement and position of printed forms on the press sheet.

Layout—1. Preliminary sketch or arrangement showing the size, position, and colors of illustrations and text. 2. A layout drawn in pencil on goldenrod paper for positioning photographic negatives (or positives) made from original copy to fit the requirements and limitations of lithographic plates, paper, and finishing.

Lead driers—Paste driers which are made from sugar of lead and manganese resinate or linoleate dispersed in varnish.

Lens—A disk of optical glass, or a combination of two or more such disks, by which rays of light may be made to converge or diverge.

Light streak—Fog produced on photographic film by extraneous light falling upon it, such as light coming through a pinhole in the bellows or light reflected from the surface of the lens.

Line copy—Any copy suitable for reproduction without using a screen; copy composed of lines or dots as distinguished from continuous-tone copy.

Linseed oil—Oil obtained from seed of flax plant. A drying oil used in mixing inks.

Lithography—A planographic method of printing based on the chemical repulsion between grease and water to separate the printing from nonprinting areas.

Lithotine—An improved turpentine from which the poisons have been removed.

Livering, ink—A stiffening or coagulation of ink due to chemical change during storage or hot milling.

Long ink—A term used to describe the consistency of lithographic inks. Ink is called "long" if

it stretches into strings when tapped between fingers; "short" if the ink breaks off short.

Longitudinal chromatic aberration—A lens aberration which affects the sharpness of all parts of an image because different colors come to a focus at different distances from the lens.

Magenta contact screen—A contact film screen composed of magenta dyed dots of variable density used for making halftone negatives in the camera.

Magenta negative—A negative in which the black silver is replaced by magenta dye.

Magnesium nitrate, $Mg(NO_3)_2$—A salt used as a buffer in fountain etches.

Magnesium silicate, $Mg_3Si_4O_{11}$—(French chalk) Used in powdered form to dust inked images in plate processing, or in combination with powdered sulfur as a blanket dust.

Makeready—The adjustment of feeder, grippers, side guide, pressure between plate and blanket cylinder, impression plate, and ink fountain prior to a press run.

Make size—An accurately scaled line denoting the size to which original copy is to be enlarged or reduced.

Masking—Blocking out areas of a sensitized film or plate from exposure to actinic light by use of such materials as goldenrod or red paper, aluminum foil, etc.

Masstone—Color of ink in mass. May differ from the printed color of the same ink.

Master film positive—A positive made from an original negative for purpose of making additional negatives.

Matte—A dull surface, lacking in gloss.

Mealy—Flecked with white or gray. Spotty.

Micrometer—A caliper used for measuring minute thicknesses such as plates, packing, blankets, etc.

Middletone—The intermediate tones between the highlights and shadows in a photographic reproduction.

Moire—An interference pattern resulting from the overlaying or overprinting of halftones or tints whose screen angles are not sufficiently separated to make the pattern inconspicuous.

Molleton—A thick cotton fabric similar to flannel used for covering dampening rollers on a lithographic press.

Monochrome—One color; of a single color, but with varying shades.

Mortising—Inserting a piece of new film to replace a cutout portion of an original film, during the negative correction phase of flat preparation.

Multicolor—Two or more colors; sometimes called *polychrome*.

Multiple burn—The intentional exposure of two or more line or halftone negatives in succession and in register on the same sensitized surface.

Negative—1. A photographic image on film, plate, or paper, in which the tones are reversed. 2. A film, plate, or paper, containing such a reversed image. In cartographic scribing, a scribed sheet is essentially a manually-produced negative.

Neutralize—Counteract or overcome acidity or alkalinity.

Nitric acid, HNO_3—A strongly corrosive acid used sometimes in counteretch solutions.

Nodal point—One of two points on the optical axis of a lens (or system of lenses) such that a ray emergent from the second point is parallel to the ray incident at the first.

Offset—An indirect printing method in which an inked image is printed on a rubber blanket that in turn prints or offsets the inked impression onto a sheet of paper.

Offset press—A press which contains an extra cylinder, rubber covered, upon which the image is printed first and then reprinted or "offset", from this cylinder onto the paper.

Opacity—A direct measurement of the extent that a photographic image will prevent the passage of light.

Opaque—1. An ink used to block out defects or areas in a film where no light transmission is desired. 2. Any material that will prevent the passage of light of particular wavelengths. Thus, a substance may be opaque to some colors and not to others. It may be visually transparent, yet actinically opaque.

Optical axis—A straight line which passes through the centers of curvature of the lens surfaces.

Original copy—The photographs, artwork,

scribed material, typed matter, or other materials to be processed for reproduction.

Original negative—That negative developed from the film which was in a camera magazine at the instant of exposure. Also called a "first-generation negative."

Orthochromatic—Photographic emulsions sensitive to ultraviolet, blue, yellow, green, and orange light waves. Insensitive to red waves.

Orthophotograph—A photographic copy, prepared from a perspective photograph, in which the displacements of images owing to tilt and relief have been removed.

Orthophotomap—A photomap made from an assembly of orthophotographs.

Overprint—New material printed upon a map or chart to show data of importance or special use, in addition to that originally printed.

Oxidation—Corrosion of press plates from slow drying. If severe, oxidation spots accept ink and plate cannot be used.

Packing—1. Paper used to underlay a blanket, plate, or proof to bring the surface to the desired height. The method of adjusting squeeze pressure. 2. The act of inserting packing material under the blanket or plate.

Pallet—A wooden platform built several inches high to allow the fork of a lift truck to slide under the paper stack and lift.

Panchromatic—Photographic emulsions sensitive to all visible spectral colors, including red.

Paper hygroscope—An instrument for measuring the moisture content of a stack of paper relative to the humidity of the pressroom.

Paraformaldehyde (trioxymethylene)—Powder that liberates formaldehyde in solution. Used in photomechanical developers.

Parallax—The apparent displacement of an object when viewed from different positions.

Paste drier—An ink drier, usually a combination of lead and manganese, used in lithographic inks; dries ink throughout with a tough surface, but less gloss than cobalt driers.

Peel (positive negative)—A technique of removing the opaque stratum from its supporting base. Peeling between etched outlines produces a negative; peeling outside of the etched outlines produces a positive.

Percent of enlargement/reduction—The factor by which an original is to be enlarged or reduced in reproduction. A 50 percent linear enlargement of a 4″ x 5″ original would be 6″ x 7½″, while a 50 percent reduction of the same original would be 2″ x 2½″.

pH—A scale used for expressing the acidity or alkalinity of solutions. The acidity or alkalinity is determined by its hyrdogen ion content: a pH value of 7 is considered neutral; solutions of a lower value are acids, while solutions higher than pH 7 are alkaline.

Photocompose—To mechanically impose one or more images by step-and-repeat exposures in predetermined positions on a pressplate or negative by means of a photocomposing machine.

Photograph—A picture formed by the action of light on a sensitized emulsion which is chemically treated to fix the image.

Photography—The process of producing images on sensitized surfaces by the chemical or actinic action of light.

Photolithography—A lithographic printing process in which photography is used to produce an image on the printing surface.

Photomap—A reproduction of a photograph or photomosaic upon which grid lines, marginal data, contours, place names, boundaries and other cultural data may be added. When certain features are overprinted in various colors, it is called a color-intensified photomap.

Photomap back-up—A photomap printed on the back of a line map of the same area and at the same scale.

Photomechanical—Any reproduction process in which photography is used in combination with mechanical means to produce a printing surface.

Photomosaic—An assemblage of overlapping aerial photographs to form a photographic representation of a portion of the earth's surface.

Picking—Removal of part of the surface of paper during printing, occurring when the pulling force of the ink is greater than the surface strength of the paper.

Pictochrome process—The process employed to produce pictomaps. Consists of three tonal sep-

arations photographically extracted from a photomosaic, block-out masks, drafted symbols, and names data.

Pictomap—A photomap product on which the photographic imagery of a standard phtomosaic or orthophotomosaic has been converted into interpretable colors and symbols by means of tonal masking techniques.

Pigment—Manufactured chemical colors, inorganic or organic. Inorganic pigments are generally opaque and produced from basic materials, including metals; organic pigments include coal tar dye for lakes and are widely used for lithographic transparent inks.

Piling—Sticking or caking of ink pigment on the plate or blanket instead of transferring readily to the intended surface.

Piling bars—A gage or upright guide to pile paper against.

Pinholes—Minute transparent spots in negatives which show up as spots on the printed image; most frequently caused by dust on the film during exposure.

Pitch diameter—Rolling diameter of a gear. On offset press, same diameter as cylinder bearers.

Planography—Printing from a plane surface in which the image areas are in the same plane as the nonprinting areas of the plate.

Plate—A thin metal, plastic, or paper sheet, that carries the printing image and whose surface is treated to make only the image areas ink-receptive.

Plucking—Lifting of surface fibers of paper sheet by ink having excessive tack.

Plugging—Flling in of shadow areas on negative or in printing.

Polish out—Removal of an image or unwanted marks from a lithographic plate by erasure with a snake stone or similar abrasive.

Polymerize—Chemical combination of organic compounds in irreversible action.

Positive—A photographic reproduction on plate, paper, or film, in which image densities are directly related to the tones of the originals.

Potassium bromide, KBr—Salt used in photographic developers to inhibit fog.

Potassium ferricyanide, $K_3Fe(CN)_6$—Used in preparing photographic reducers and blueprint solutions.

Precision camera—A relative term used to designate any camera capable of giving dimensional and definition results of a definite high order of accuracy.

Preservative—A chemical combined with any substance to prevent it from decomposing or changing its composition.

Press proof—A lithographed impression taken from among the first copies run on the press and used for checking purposes.

Print—A photographic copy made by projection or contact printing from a negative or transparency.

Prism—A transparent body bounded in part by two nonparallel plane faces. Used photographically to reverse the image on the sensitive emulsion.

Process lens—A lens for photomechanical copying, enlarging or projection purposes, free from aberrations, usually of low aperture and of symmetrical construction.

Process photography—Line and halftone photography in which the resulting negatives and positives are subsequently used in the preparation of press plates.

Progressive proofs—An assembled series of color prints that show the individually separated color printings of a job and their progressive combinations as each color is added (overprinted).

Proof—A trial print, produced by any method from the reproduction material, for examination and editing.

Proofing—The operation of pulling proofs of press plates for checking, revising, approval, and other purposes prior to production printing. Sometimes called "proving."

Pull—An impression of print from a lithographic plate.

Punch—To perforate.

Rag stock—Paper containing rag pulp.

Ratio print—A print in which the scale has been changed from that of the original negative or transparency by projection printing.

Ream—A quantity of paper, usually 500 sheets.

Reducers—1. Chemicals used to reduce the density of negative or positive images or halftone dots. 2. Varnishes, solvents, or oily compounds used to change the consistency of printing inks.

Reduction diagram—Chart showing the necessary lens extension and copy board extension required for different reductions.

Refraction—Bending of light in passing obliquely from one transparent material to another.

Register—Exact agreement in position of the various components of a composite image.

Register marks—Small crosses, guides, or patterns applied to the original copy prior to reproduction and used for positioning.

Relative aperture—The ratio of the equivalent focal length to the diameter of the aperture. Expressed as f 4.5. Also called f number or speed.

Relief—The elevations and topography of a land surface, usually represented by contours.

Reprint—The process of using existing reproducibles to print additional quantities of maps, charts, or publications.

Reproducible—Any copy capable of being used to prepare a printing plate.

Reproduction—Mapping: 1. The summation of all the processes involved in printing copies from an original drawing. 2. A printed copy of an original drawing made by any process of reproduction.

Residual chemicals—A very thin film of chemical solution always left on a metal lithographic plate after processing.

Resolution—The ability of an entire photographic system, including lens, exposure, processing, and other factors, to render a sharply defined image, usually expressed as lines per millimeter, recorded by a particular film under specified conditions.

Resolving power—A mathematical expression of lens definition, usually stated as the maximum number of lines per millimeter that can be seen as separate lines in the image.

Restrainer—The chemical, usually potassium bromide, in a developer which retards development and chemical fog.

Reticulation—Breakup of gelatin emulsion into wormlike pattern, usually due to temperature changes or excessive hardening and drying in processing.

Retouching—Corrective treatment of a plate, negative, positive, or copy by means of brush, pencil, pen, air brush, etc.

Reverse plates—Plates on which image tones are reversed from those of the original copy.

Right-reading—An image which, when viewed through the base, reads the same as the original.

Roller streaks—Elongated streaks, plainly visible on large tints or solids; caused by uneven contact of the inking rollers.

Rolling up—The inking of a finished plate without making a proof or impression. Usually done by hand to protect the image or to make inspection easier.

Run—The number of impressions made on the press from a given press plate.

Safelight—A colored source of illumination to which photographic materials are relatively insensitive. Red light usually is used for orthochromatic, and faint green for panchromatic materials.

Safety film—A film with a cellulose acetate base which will not burn readily.

Scale of reproduction—The ratio of enlargement or reduction of an original to the final reproduction; expressed as a percent, diameter, times (x), or a fraction.

Screen angle—The angle the rows of halftone dots make with the vertical when right reading. The angle is measured clockwise with 0 degrees at 12 o'clock.

Screen distance—The separation or space between the surface of a glass screen and the photographic emulsion during exposure in the camera.

Screened line plate—A plate made through a screen, resulting in a screened image instead of a continuous tone image.

Scribing—The process of preparing a negative manually which can be reproduced by contact exposure. Image portions of a photographically opaque coating are removed from a transparent base with specially designed tools.

Scum—Film of ink accepted by nonprinting

areas of plate; basically due to spots or areas not remaining desensitized.

Sensitivity guide—A gray scale exposed on the plate with the image, which, when developed, indicates the sensitivity of the coating and measures the tone values reproduced on the plate.

Sensitizer—The light-sensitive solution (salts of iron, silver, and chromium, also diazo compounds and dyes) used to make photographic surfaces and lithographic plates light sensitive.

Sensitometry—The measurement of the response of a photosensitive material to the action of light.

Set—A group of reproducibles from which a map or chart can be lithographed.

Sharpness—1. A measure of the ability of a negative material to reproduce geometrically sharp edges. All emulsions reproduce such edges as graded transitions. Sharpness is one factor which determines the best definition which can be obtained in a negative. 2. An expression used to indicate critical focus.

Short ink—Ink of low elasticity and high pigment content that cannot be pulled into a thread when tapped between the fingers.

Signature—A single group of folded pages in units or multiples of four which form sections of a book for binding.

Silver bromide, AgBr—Silver salt sensitive to light. Used in photographic emulsions.

Silver chloride, AgCl—Sensitive salt used in paper emulsions.

Silver print—Photographic print on paper sensitized with silver chloride. Sometimes called a "sepia print."

Size—1. To coat with any of the various glutinous materials used for filling the pores in the surface of paper or fiber. 2. To calculate the measurements required in photographing a map to a desired scale.

Slip sheets—Sheets of paper manually placed between printed sheets to prevent offsetting of ink or between negatives to prevent scratches.

Snakeslip—*See* etch slip.

Sodium benzoate, $Na_7H_5O_2$—Preservative for organic materials.

Sodium bicarbonate, $NaHCO_3$—Weak alkali used to assist pressplate development.

Sodium carbonate, Na_2CO_3—Accelerator for photographic developers.

Sodium hydroxide, NaOH—Powerful alkali used in solution to remove old images from pressplates.

Sodium sulfite, Na_2SO_3—Preservative for photographic developers.

Sodium thiosulfate (Hypo), $Na_2S_2O_3$—Used for dissolving underdeveloped silver salts.

Specific gravity—Ratio of density of a material to water.

Spectrum—The band of visible colors formed when a ray of light is separated by means of a prism or diffraction grating.

Speed—The response or sensitivity of photographic material to light, often expressed numerically according to one of several systems.

Speed of lens—The ratio of the equivalent focal length to the diameter of the aperture at the maximum diaphragm opening.

Sperical aberration—Lens distortion in which light from outer zone of lens does not focus in same plane as light from inner zone.

S.R.—Abbreviation of "Scale of Reproduction."

Stable base—A general term applied to film bases, and mapping and reproduction materials possessing a high degree of dimensional stability.

Staging—Applying a protective coating in selected areas to protect these areas when chemicals are applied to the general area.

Stepover—In multiple imposition on a lithographic press plate, the procedure of repeating the exposure of a flat by stepping it along the gripper edge; side-by-side exposure.

Step-up—In multiple imposition on a lithographic press plate, the procedure of repeating the exposure of a flat by stepping it back from the gripper edge of the plate; up-and-down positioning.

Step wedge—A strip of film or a glass plate whose transparency diminishes in graduated steps from one end to the other, used to determine the density of photographic copy. Also called *Gray scale.*

Stereoscopic plotting instrument—An instrument permitting an operator to plot a map by observation of the stereoscopic model formed by a single stereoscopic pair of photographs.

Stick-up—A gum or wax-backed material, either translucent or opaque, on which names, numbers, or symbols are printed for the purpose of imposing them on map manuscripts, thereby eliminating hand drafting.

Stopping out—Painting areas with a protective fluid.

Strip film—A photographic film in which the emulsion membrane can be removed from its temporary base after exposure and processing; the membrane is then transferred to a new base.

Stripping—1. The cutting, attachment, and other operations for assembling cut film sections to produce a flat. 2. The refusal of press rollers to accept ink, caused by glazing or driers.

Suckers—Rubber or metal suction cups which lift and carry paper sheets forward.

Surprint—An additional image overprinted on the image of previously printed areas.

Tack—Stickiness of ink; the resistance to splitting of an ink film between two separating surfaces. This property of ink enables the ink to adhere to paper and to trap inks of succeeding impressions.

Talcum powder or Talc—*See* Magnesium silicate.

Tan—Rendering colloids insoluble by chemical or light action.

Thixotrophy—The property of some inks of becoming fluid when worked and setting to a semi-isolid state when at rest; the cause of some inks tending to back away from the ink fountain roller.

Times (x) enlargement—The multiplication factor by which an original is to be enlarged in reproduction. A two-times (2x) enlargement of a 4" x 5" original would be 8" x 10". *See also* diameter enlargement, scale of reproduction.

Tint—1. An allover color tint on the press sheet caused by ink pigment dissolving in the dampening solution. 2. Color gradations used on maps to designate depth or height.

Tone—Each distinguishable shade variation, from black to white.

Transmission—The light-transmitting ability of a material expressed as a ratio of the transmitted to the incident light.

Transparency—A photographic print on a clear base, especially adaptable for viewing by transmitted light. Also, the light-transmitting capability of a material.

Trap—Ability of ink on paper to accept subsequent colors. (*See* Tack.)

Trim marks—Lines placed on original copy to serve as guides in cutting or trimming the printed sheets to their prescribed size.

Trim size—The overall dimensions of a final printed product.

Trisodium phosphate—Used as cleaning agent and rust inhibitor in plate-graining.

Two-step enlargement/reduction—A technique of projecting and printing a small image, then projecting and copying it again to the required size. This is often necessary when copy size/copy camera limitations do not permit enlargement or reduction in a single operation.

Type—In printing, a metal block having a raised letter or figure which, when inked, is used to make an impression on paper or other material. Type can be in the form of hand-set cold type; hot type, such as linotype; punched tape to metal (monotype); film negative or positive (photo type); or tape to film (photontype). Type is identified by its style and size.

Ultraviolet light—Radiation of wavelengths just short of the visible spectrum. A wave length of ultraviolet light runs from 1,500 to 4,000 angstrom units. Used to excite fluorescent dyes, pigments, or materials to render them visible.

Undercut—In printing presses, the difference between the radius of the bearers and the radius of the cylinder body; the allowance for plate or blanket plus a margin for packing adjustment.

Undercutting—The spread of light beyond the transparent areas of a negative or positive during exposure. Frequently due to local out-of-contact areas between emulsion surfaces.

Varnish—Usual lithographic vehicle for inks. Prepared by boiling linseed or other drying oilts. (*See* Linseed oil.) Varnishes are numbered from No. 0000 to No. 8, or higher, corresponding to their increasing viscosity resulting from extended boiling. No. 8 varnish is frequently called "body gum."

Vehicle—Liquid used to hold pigments together and give ink its working properties. (*See* Varnish.)

Vignetting— 1. (photography) A gradual reduction in density of parts of a photographic image owing to the stopping of some of the rays entering the lens, as when a lens mounting interferes with the extreme oblique rays. An antivignetting filter is one that gradually decreases in density from the center toward the edges; it is used with many wide-angle lenses to produce a photograph of uniform density by cutting down the overexposure of the center of the photograph. This principle is employed in the magenta halftone screen, where light reflected from the image passes through vignetted dots, and thus forms dots of varying sizes according to its intensity. 2. (lithography) A photographic process which portrays a solid color in a screen which shades off gradually into the unprinted portions of the paper. Open water on a map is often shown by this method.

Viscosity—Resistance to flow; the opposite of fluidity.

Walk off—Failure of part of a lithographic image to adhere to the metal plate; parts of the image disappear during the press run.

Wash drawing—Made by a brush in washes with a single color, usually black, to be reproduced by halftone.

Washout—Removal of ink from printing areas of pressplate and replacing it with an ink-receptive asphalt or other varnish that can be redissolved.

Washup—Cleaning the rollers or press.

Wave length—The distance between two crests of a wave, generally expressed in angstrom units or millimicrons in the shorter waves (ultraviolet, visible, infrared, etc.) and in kilocycles for the higher wave lengths (radio).

Wedge—Metal or wood in a wedge form, the thickness of which is generally graduated in 64ths of an inch, used in measuring the screen separation.

Wetting agent—Chemicals that facilitate mixing of solids with liquids by lowering surface tension. Used to promote uniform wetting and drying.

Winding stock—Separation of paper stock by jogging and flexing to ventilate or get air between the sheets.

Work-and-back (sheetwise) layouts—A work-and-back layout provides for separate plates to print the front and back of a signature. When one side of the sheet has been printed, the sheets are laterally reversed and the backup printed using a second plate. The same gripper edge of the sheet is used for the second press run.

Work-and-turn layouts—These layouts are used to print two or more complete signatures on one press sheet. The front and back pages are positioned on the same flat, so arranged that when one side of the sheet is printed, it is then laterally reversed and printed using the same plate. The same gripper edge and same side of sheet is used for positioning during both press runs.

Work-and-tumble layouts—Work-and-tumble layouts use the opposite edges of the press sheet as alternate gripper edges in printing both sides of the sheet. This type of layout also uses the same front and side guide positions. The press sheets are turned over from top to bottom when the backup is printed. Since this results in two different gripper edges, the paper stock must be trimmed accurately on all four sides to assure good register.

Wrong-reading—An image which, when viewed through the base, is a reversed or mirror image of the original.

Yield value—Measure of rigidity of ink.

INDEX

By Order of the Secretary of the Army:

W. C. WESTMORELAND,
General, United States Army,
Chief of Staff

Official:

KENNETH G. WICKHAM,
Major General, United States Army,
The Adjutant General.

Distribution:

Active Army:

DCSLOG (2)
CofEngrs (2)
USAMERDC (2)
AMC (2)
CONARC (2)
USAFABDC (2)
USAIB (5)
USARADBD (3)
USAAESWBD (3)
USAAVNTBD (3)
ARADCOM (2)
OS Maj Comd (2)
LOGCOMD (2)
MDW (1)
Armies (3)
Corps (3)
Div (2)
Engr Bde (5)
Engr Gp (5)
Engr Bn (5)
Instl (2)
PMS Sr Div Units (3)
USMA (5)
Svc Colleges (2)
Br Svc Sch (5) except
USAES (650)
Div Engrs (1)
Dist Engr (1)
USATOPOCOM (500)
USAMECOM (2)
MAAG (2)
Units org under fol TOE:
5–305 (5)
5–306 (2)
5–308 (2)
5–327 (2)
5–346 (5)
5–347 (5)
5–348 (2)
5–349 (2)
5–540 (5)

NG: State AG (3) units: same as active Army except allowance is one copy to each unit.
USAR: Same as active Army except allowance is one copy to each unit.
For explanation of abbreviation used, see AR 310–50.

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